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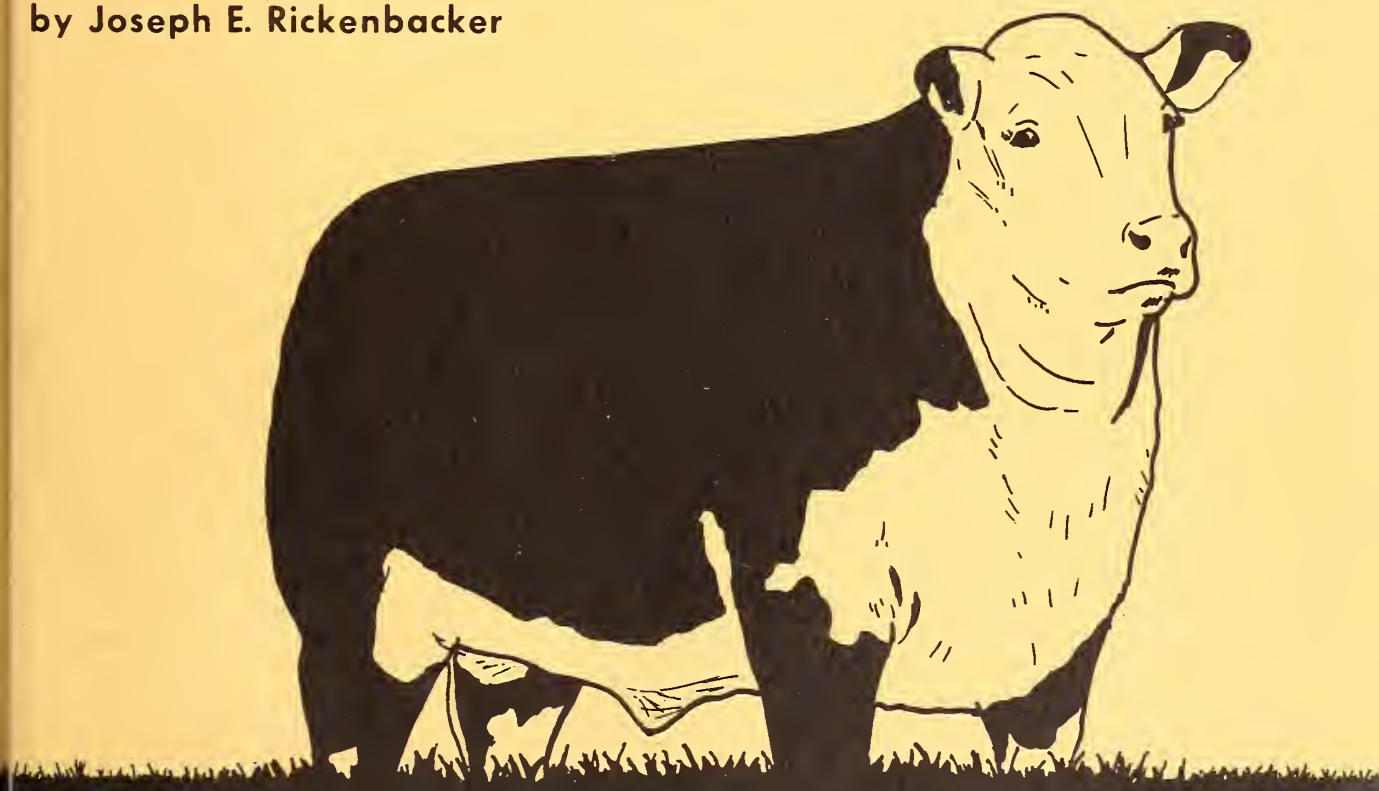
Handling Conditions and Practices Causing Bruises in Cattle

by Joseph E. Rickenbacker



Farmer Cooperative Service ● U. S. Department of Agriculture

FARMER COOPERATIVE SERVICE
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

Joseph G. Knapp, Administrator

The Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, merchandising, product quality, costs, efficiency, financing, and membership.

The Service publishes the results of such studies, confers and advises with officials of farmer cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

This study was conducted under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

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Summary

Bruise injury has been a major problem for the livestock and meat industry for many years. Carcass bruises, particularly in cattle, represent one of the major loss areas in the industry. This loss has been estimated as being substantially higher than that from crippling and death in transit. On the basis of results obtained in the tests made as a part of this study, the national loss on cattle from carcass bruise damage is probably around $12 million a year.

It is difficult to say precisely who bears this loss because of the complexities of livestock marketing and processed meat merchandising. Each segment of the industry—producer, transporter, market agency, packer, and even the consumer—bears the loss in whole or in part at one time or another.

A major obstacle to effective loss control and reduction has been this inability to fix the responsibility for bruise injury. Cattle pass through many hands during marketing and processing and carcass damage is generally not discernible until after slaughter. Thus, time, place, and cause of damage have been sufficiently indefinite as to permit almost any handler of the cattle to deny, or at least question, any part of his responsibility for the loss.

Because farmers and their livestock marketing agencies are so vitally concerned with this loss area, Farmer Cooperative Service began a study of the bruise loss problem in 1954. Arrangements were made with the Ohio State University and the Ohio Agricultural Experiment Station to develop a means of helping fix the responsibility for bruise damage.

Although this study did not definitely fix responsibility for bruise loss, laboratory research produced much valuable information useful in considering the problem of cattle bruises: For instance, animals may be bruised at any time up until the blood pressure approaches zero—even after stunning. Carcass location, degree of impact, and the emotional state of the animal have an influence on bruise injury. Animals, somewhat like human beings, have varying degrees of "susceptibility" to bruising. This may sometimes be explained or influenced by previous bruising or by introducing compounds into the system to retard bruises.

To more positively establish the cause of these bruises, Farmer Cooperative Service initiated research under conditions generally prevailing in the marketing and processing of cattle. We assumed that certain practices and conditions involved in handling the cattle could be related to carcass damage from bruising.

This assumption, in turn, was based on the premise that some bumps cause bruises. During the handling and processing, bumps frequently happened. Previous investigations by Farmer Cooperative Service, in cooperation with Livestock Conservation, Inc., indicated that bumps were likely to cause bruises.

In this study researchers tabulated bumps on test lots of cattle from loading through slaughter on the basis of individual cattle by carcass location and handling phase. These data were then checked against a record of actual carcass bruise damage obtained after the test animals were slaughtered.

Thirteen tests were conducted in the Midwest and Rocky Mountain areas during 1958, involving a total of 720 head of cattle of various weight, sex, and grade. The animals were slaughtered at five different packinghouses. The total bruise loss on the cattle used in the tests amounted to $60.40 per 100 head. About one-third represented loss due to tissue trim itself and the balance was attributed to devaluation of the side because of excessive trim.

Largest losses were in the hip or loin area, both on the basis of trim weight and financial loss. Shoulders accounted for the second highest loss area.

The bruise loss on steers was approximately three times that suffered on heifers. Likewise, higher grade cattle suffered less carcass bruise damage than did plainer grades.

The largest number of bruises occurred after the animals were in the packers' hands; that is, during the movement from packer holding pens through slaughter. Although about three times as many bruises were identified with this slaughter phase, the financial loss was almost twice as large as that attributed to other handling phases. This result indicated that severity of bruise injury was greater during loading, unloading, and the like.

These tests pointed clearly to certain causes of carcass injury that could and did occur in all handling phases. These were (1) animal characteristics; (2) facilities involved in transporting and handling animals; (3) handling techniques; (4) actions and attitudes of personnel actually moving or handling the cattle; and (5) such miscellaneous factors as weather conditions, length-of-haul, and the like. Certain of these were of greater importance during one handling phase than others.

No single segment of the industry can be saddled with full responsibility for bruise loss. Rather, bruise loss is an industrywide problem. There was positive proof that livestock could be moved safely and without injury, since 30 percent of the test animals went through unscathed.

We believe two approaches are likely to yield worthwhile results in coping with the bruise problem. Adopting safe, simple facilities would enable handlers to make full use of the most approved handling techniques. Promoting safe-handling programs would alert handlers to the close relationship of their attitudes and actions to bruise loss.

Although somewhat remote at the moment, some relief may develop from products which can be administered to cattle economically and easily to raise the native bruise resistance of the animal. Some steps have been taken to initiate research programs to bring this about.

Handling Conditions and Practices Causing Bruises in Cattle

by
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The livestock industry loses millions of dollars each year from loss and damage to meat animals during marketing and processing. Some of these losses are obvious, such as dead or crippled animals arriving at a public market or a processing plant. Others might be more properly termed concealed losses—bruise injury, shrink and disease, and the rather intangible one generally referred to in the trade as "loss of market bloom."

Many of these losses, if not all of them, may be in whole or part closely associated with transportation. This is particularly true if we think of transportation as including all handling from the time the animals are first sorted for shipment, through all the various stages of marketing, until the animal is actually slaughtered at the processing plant.

However, the loss may also be caused by a condition which occurred before the transportation phase. For example, an animal in a weak or emaciated condition may die during the trip. In a sense this loss would be a transportation loss but the real blame belongs to the producer.

To consider these problems of livestock losses in transit, Farmer Cooperative Service began a research project in 1954. This survey indicated that the total economic loss due to death and crippling was approximately $8 million a year at average annual prices for 1955 and 1956.[1] In general, dead and cripple losses among animals hauled by motortruck exceeded those among animals moved by railroad, often by substantial margins.

During 1956, FCS conducted a special truck survey at 8 major public markets of some 6,400 loads of live animals observed during unloading. This survey revealed definite "loss associated conditions" which occurred in vehicles containing dead and crippled animals, or both. These loss associated conditions included such things as obvious overcrowding, improper bedding, inadequate or improper ventilation, excessive use of persuaders and failure to use partitions where needed.[2]

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[1]Rickenbacker, Joseph E. Losses of Livestock in Transit in Midwestern and Western States. Mar. Res. Rpt. No. 247. Farmer Cooperative Service, U. S. Dept. of Agr. June 1958.

[2]Rickenbacker, Joseph E. Causes of Losses in Trucking Livestock. Mar. Res. Rpt. No. 251, Farmer Cooperative Service, U. S. Dept. of Agr. June 1958.

The problem of bruise loss has been of even greater significance than dead and cripple losses and extremely vexatious to the industry.

Because bruise damage is usually not discernible until after the animal is slaughtered and the hide removed, it has always been extremely difficult to fix responsibility for the bruise. This situation prevented setting up programs to curtail these losses.

There has also been a great deal of controversy over the question of who pays for the cost of the bruise. Complexities of livestock marketing have made it impossible to give a specific answer. At one time or another, each segment of the industry--the farmer, the transportation agency, the market agency, the packer, and even the consumer--has stood the loss, in whole or in part. Certainly each recognized that the losses did occur and that somebody paid for them.

To reduce bruise losses, FCS felt the most effective way would be to develop some method of positively determining the responsibility for the damage. Then educational programs could be instituted which might result in improving conditions to the point that such losses could be minimized.

We decided the only practical means of determining bruise responsibility would be through a study of the bruise itself. After consulting with various research agencies, we concluded that determining the "age of a bruise" could lead to the person or agency responsible for it.

For example, if the age of the bruise could be set at 24 hours, and the animal had been on a truck en route to market 24 hours before slaughter, the bruise would have been caused by something that happened in the motor vehicle. The trucker would then be responsible for the loss.

FCS approached this problem of bruise loss on two fronts: (1) through experimental research under laboratory controlled conditions; and (2) special research under ordinary conditions prevailing during the marketing and processing of cattle.

Research to determine the age of bruised tissue was begun in 1954 by the Ohio State University and the Ohio Agricultural Experiment Station, under contract with Farmer Cooperative Service.

Researchers found that they were entering a virtually uncharted field. Not only had there been no work done on livestock bruises but very little was known about human bruises.

These researchers conducted experiments under strict laboratory controlled conditions and used selected lots of animals.

Their research developed many significant findings.

They learned a great deal about the structure of a bruise. Now one can estimate in a general way the approximate age of bruised tissue by closely examining the color of the tissue itself as well as the appearance externally on a living animal.

Unfortunately, the researchers were unable to develop a simple test which could precisely determine the age of a given bruised tissue. But two tests were developed, one based on color changes in the bruised tissue, and another based on the conductivity of the tissue. These tests are able to establish age of bruised

tissue in rather broad categories, such as less than 60 hours old, 60 to 72 hours old, 3 to 4 days, 4 to 8 days old, and over 8 days old. These categories have limited use in fixing responsibility for bruise loss because most cattle are moved to market one day, sold the next and slaughtered on the third day.

Findings disclosed animals may suffer bruise injury at any time up until the blood pressure falls to approximately zero. This means that the carcass can be bruised after stunning at a slaughter house.

Animals of the same type and grade had varying degrees of susceptibility to bruise. This susceptibility was influenced by different factors. For example, an animal that had suffered a previous bruise was not as susceptible to a second bruise, and, if he suffered a second and then a third, the third bruise was likely to be less severe and to heal more rapidly than the second. The location on the carcass and the relative force of impact greatly influenced both the extent and severity of bruise damage.

Emotional state of the animal also exerted a very strong influence on susceptibility to bruise damage. Animals highly excited and nervous bruised more easily than those who were in a more calm or normal "frame of mind."

All of these findings were tremendously important from a scientific standpoint alone, but more importantly, they pointed to ways of reducing bruise loss.

The laboratory work and the findings set the stage for the work undertaken in this report involving ordinary marketing and processing of cattle.[3]

Bruise Test for Cattle Under Ordinary Market Conditions[4]

In the ordinary marketing and processing of livestock, cattle pass through many hands. This was a complicating factor in designing a test for use under these conditions. The problem was met by limiting the test animals to cattle already owned by the packing concern before movement to slaughter, or "directs" as they are called. The use of such directs not only reduced the number of hands through which test cattle passed but also eliminated the possibility of losing test shipments by having them sold for disposition off the market or to non-cooperating packers.

Since climate considerations are not as important in the case of cattle as in other species of livestock, it was not necessary to spread the tests over the various seasons of the year. The number of test lots, however, provided a sample that covered the various classes and grades of cattle. The tests were

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[3]For reports on certain aspects of the research done at Ohio State University, refer to the following articles and publications:

Hamdy, Deatherage, and Shinowara. Bruise Tissue. I. Biochemical Changes Resulting from Blunt Injury. Proc. of the Soc. of Explt. Biol. and Med. 95: 255-258, 1957.

Hamdy, Kunkle, Rheins and Deatherage. Bruise Tissue. II. Determination of the Age of a Bruise. Jour. of Animal Sc. Vol. 16, No. 2. May 1957.

Rickenbacker, Joseph E. Biochemical Problems in Determining the Age of Bruised Animal Tissue. Serv. Rpt. 42. Farmer Cooperative Service, U. S. Dept. of Agr. 1959.

[4]An expanded discussion of the methodology and philosophy of this test is included in the appendix. A detailed description of an actual test, illustrating all the techniques and procedures used, also appears in the appendix.

conducted at a sufficient number of plants and loading points to allow for variations in facilities.

We designed the test to relate potential injury causing factors—bumps between two animals or into objects—to carcass bruise damage. Hence, the popular name for the test—a "bump-bruise" test.

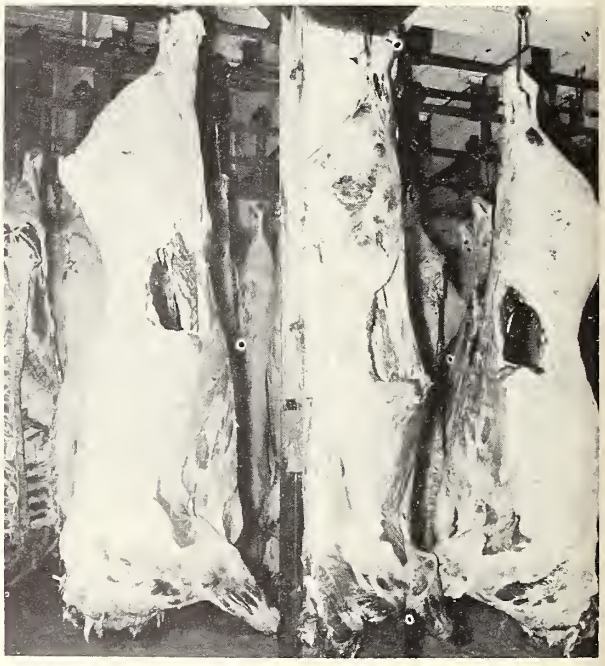
Observation of test animals covered the time from the beginning of loading into the truck for transport on through slaughter. Although this arrangement did not take into account any conditions which may have existed before loading time, it was the only practical period for observation. The use of stanchion-fed animals would have met this shortcoming but here we would have been falling back on laboratory-like conditions. Instead, we selected test lots that had been on feed for a minimum of 60 days before shipment, which entailed minimum pre-shipment handling and bruising.

To facilitate the association of potential bruise injury with specific handling incidents, we broke the observation period into specific handling phases. These phases, largely self-explanatory, were: loading, in transit (over-the-road haul), unloading, yarding, and slaughter. Slaughter is better considered as a two-part phase, one part involving movement to the knocking box and thereafter up to sticking.

We further insured identification by recording the potential bruise injuries by carcass location—right or left side and by general body area—hip, rib, shoulder, and the like. Each animal in the test lot was individually identified by a number applied to the hip area before loading. After slaughter, the carcass carried the same number on a metal tag placed in the brisket. This tag remained there until the carcass was ready for shipment.

Observers recorded the potential injuries. These observers stationed themselves at points best suited for keeping the cattle under close scrutiny during each handling phase. They used portable tape recorders since this allowed for instantaneous recording of observations. The tapes were subsequently transcribed on individual cards for each animal (figure 1).

After slaughter, the observers recorded all bruise injuries by individual animal on the basis of carcass location. After each trim-out of tissue was weighed, the observers noted various body marks likely to have been caused by impact. They rechecked the carcasses



These sides of beef illustrate what happens when cattle sustain severe bumps during handling. Not only is the trimout lost but the whole side must be reduced in price before it can be sold.

HEAD NO.	DATE	PLANT	LOT NO.	POSITION	TYPE	GRADE	REMARKS

BRUISE RESULTS

$ LOSS	LEFT NO. PB	LEFT NO. T	LEFT RATE	LEFT LOSS	RIGHT NO. PB	RIGHT NO. T	RIGHT RATE	RIGHT LOSS
HIP								
RIB								
SHOULDER								
OTHER								
TOTAL								

LOADING

	L	R
H		
R		
S		
O		
T		

UNLOADING

	L	R
H		
R		
S		
O		
T		

YARDING 1

	L	R
H		
R		
S		
O		
T		

YARDING 2

	L	R
H		
R		
S		
O		
T		

YARDING 3

	L	R
H		
R		
S		
O		
T		

BUMP TOTAL

	L	R
H		
R		
S		
O		
T		

ter 24 hours in the packinghouse cooler. At this time, they obtained carcass weight and the packer grade which is more detailed than the standard USDA terminology.

In addition, the packer estimated carcass devaluation, if any, for recording at this time. This devaluation was applied to those sides sufficiently damaged by bruising as to make it necessary for the entire side of beef to be reduced in price in order to market it. Thus, such sides represented a "double loss"—trim loss (the value of bruised tissue trimmed-out) and devaluation loss (a reduction in value of the whole side due to bruise damage). The devaluation loss was usually stated in fractions of a cent per pound, ranging from one-half cent up to 3-1/2 cents. All information obtained during the two post-slaughter checks went on the individual animal's record cards.

The record of potential bruise-causing incidents obtained during the observation periods included all that happened to the animal which might have resulted in carcass injury. The post-slaughter records gave a complete picture of bruise injury and loss. By correlating the two records, we determined the relationship of potential bruise-causing incidents to actual carcass and monetary loss.

Bruise Losses

The Farmer Cooperative Service survey consisted of a series of 13 tests covering 720 cattle. The test described in the appendix, page 78, was one. The test animals were slaughtered at five different packing plants operated by four different companies. In five of the tests, the animals were delivered directly to the packer at his own plant, while in the remaining tests the animals were unloaded at a public stockyard and subsequently delivered to the packer. (This is not to imply that the test animals received at the public stockyards went through the same "yarding" as animals normally offered for sale at a public market would go through).

In all instances, a for-hire trucker moved the animals, except for two tests where the feed lot operator drove the trucks. In each test the animals were transported from ranch or feedlot to the packer on one day, slaughtered the next, and the cooler check made the third day.

The data obtained during the various tests were tabulated and analyzed on several different bases. These included: (1) carcass location; (2) whether steer or heifer; (3) by individual test; (4) by grade—choice, good or standard (steers and heifers tabulated separately, as well as combined into an "all cattle" classification); and (5) by handling phase on the basis of carcass location. For the sake of uniformity, as well as easy comparison, all results were tabulated on the basis of theoretical 100-head lots.

Location on Carcass

Table 1 provides a summary on a 100-head-lot basis of general bruise information obtained in all 13 of the tests. It shows the number of trim bruises, the number of fire bruises (inflamed or reddened spots on the fatty surfaces of the carcass which are not trimmed), the pounds of trim tissue and the value of that trim, the devaluation loss, and the total financial loss on the basis of the carcass locations used in the reporting forms. These locations were the hip, rib, shoulder, and the general category "other."

Table 1.—*Bruise loss per 100 head by carcass location*

Carcass location	Number "trim" bruises	Number "fire" bruises	Pounds trim tissue	Financial trim loss	Devaluation loss	Total financial loss
Hip	25	26	16.9	$11.54	$21.32	$32.86
Rib	10	7	4.8	2.37	2.33	4.70
Shoulder	29	39	13.2	5.27	4.29	9.56
"Other"	16	21	7.0	3.18	10.10[1]	13.28
Whole carcass	80	93	41.9	22.36	38.04	60.40

[1]Includes sides devalued because of multiple minor bruises over the carcass, "fiery" appearance, and general carcass condition due to bruising.

Without regard to actual carcass location, overall bruise loss amounted to $60.40 per 100 head. This figure represents $22.36 trim loss and $38.04 devaluation loss. The trim loss was due to 41.9 pounds of trim tissue taken from 80 carcass bruises. There were 93 fire bruises.

Although $60.40 per hundred head may seem a small figure, it nonetheless represents a significant loss to whatever segment of the industry has to bear it. If we assumed that was an average loss and projected it for total annual slaughter in the United States, the loss due to carcass bruise injury in 1957 would be in the neighborhood of $12 million—a rather substantial figure.

Without giving any consideration to financial loss, the hip and shoulder areas of the cattle appeared the most frequently abused or injured portions. Between them, they accounted for about 68 percent of the total number of trim bruises, with the shoulder receiving a slightly larger number of such bruises than did the hip. Likewise, these two carcass locations accounted for the majority of fire bruises—about 70 percent. With this type bruise, however, the ratio of shoulder fire bruises to hip fire bruises was 3 to 2.

The rib area sustained only about 12 percent of the trim bruises and 7-1/2 percent of the fire bruises.

Weight of tissue removed from the trim bruises was likewise largely concentrated in the hip and shoulder areas—about 72 percent. But while the shoulder area suffered the largest number of trim bruises, the heaviest actual trim on a weight basis was in the hip area. Looking at the results from an economic standpoint, the significance of hip injuries becomes quite apparent. Bruise injury sustained in this area accounted for 52 percent of the financial value of all trim loss and 56 percent of the total devaluation loss. This is not surprising, however, since the loin or hip area embraces the highest priced cuts of dressed beef.

For example, during the time that these tests were being conducted, choice loins (from hips) were selling for 60 to 68 cents a pound, whereas shoulder cuts were moving at about 38 to 40 cents a pound.

The high devaluation loss suffered due to damaged hips or loin can be explained on much the same basis. The devaluation was assessed against the side of beef in most instances because the most desirable section of the side had been

damaged. The trade would not accept the side at a price which would represent carcass weight times carcass price.

Only a relatively small number of sides were devalued for any reason other than a hip or loin injury.

In some instances, trimming multiple bruises gave the side an overall ragged appearance, rendering it a little less desirable. A small discount had to be made to move it. Of the total number of devalued sides, about 17 percent were discounted because of multiple bruising, and the like.

In discussing these figures with the cooperating packers in the survey, we discovered two things: (1) the trim loss was somewhat higher than had been suspected—actually very few packers indicated that any effort was made to keep track of such loss; and (2) the percent of total loss from hip or loin injury was somewhat lower than had been thought to be the case. Generally speaking, packers indicated that hip injuries or loin bruises probably represented two-thirds to three-fourths of total bruise loss. Figures obtained during these tests indicated that such injuries accounted for somewhat less than 55 percent of total loss.

Type of Cattle

Data obtained during the various tests were tabulated by steer or heifer to see if there was any significant difference in bruise loss as between animal type (table 2). From a financial standpoint, the total bruise loss on steers was approximately three times as great as that on heifers. The trim loss on steers was roughly double that of heifers. From the standpoint of devaluation loss, in some cases over four times as much financial loss occurred on the steers as did on the heifers.

Insofar as actual number of trim bruises was concerned, the two types of

Table 2.—*Bruise loss per 100 head by type of cattle and carcass location*

Type of cattle and carcass location	Number "trim" bruises	Number "fire" bruises	Pounds trim tissue	Financial trim loss	Devaluation loss	Total financial loss
Hip						
Steers	29	25	21.0	$14.31	$28.13	$42.44
Heifers	19	29	10.1	6.94	10.01	16.95
Rib						
Steers	13	7	6.6	3.22	3.73	6.95
Heifers	5	8	1.8	.97	0	.97
Shoulder						
Steers	29	42	15.1	5.93	6.87	12.80
Heifers	29	34	10.0	4.18	0	4.18
"Other"						
Steers	16	21	8.1	3.62	14.74[1]	18.36
Heifers	15	21	5.3	2.47	2.40[1]	4.87
Whole carcass						
Steers	87	95	50.8	27.08	53.47	80.55
Heifers	68	92	27.2	14.56	12.41	26.97

[1]Includes sides devalued because of multiple bruises over the carcass, "fiery" appearance, and general carcass condition due to bruising.

cattle did not differ too greatly—87 trim bruises on steers and 68 on heifers, or about 25 percent more for steers. But the intensity of bruise on steers was much greater, for the trim weight for steers was about 87 percent greater than for heifers. This, of course, accounted for the higher value of trim loss.

Each type suffered approximately the same number of fire bruises. If the two types of cattle were compared from the standpoint of bruises on each carcass location, the same general pattern was observed.

One principal exception should be noted—considerably more sides of the carcass of steers were devalued than for heifers. This shows up in table 2 under the devaluation loss column for the carcass category "Other." The devaluation loss on steers was about seven times as great as that on heifers. This difference was accounted for primarily by the sides that were devalued for the multiple bruise injury and general carcass appearance. This usually means that the entire carcass was more or less "firey."

Why was the loss on steers greater than on heifers? At least a partial answer may be obtained from observations made of cattle handling during the survey.

In the first place, steers generally were larger—they not only weighed more but they were bigger framed. When the steer moved through narrow facilities, the distances between its sides and the sides of the facility (alleyway and so forth) were much less than for the smaller heifers. Therefore, the likelihood of impact and subsequent bruise injury was greater. This added weight and size also made steers somewhat more awkward and clumsy during the various handling procedures.

The general reaction of the two types of animals to handling had some bearing on the higher steer bruise loss. Heifers were somewhat more skittish, particularly in the first handling phase of sorting and loading. Steers reached higher emotional excitement, evidenced by fear or at least by actions which indicated fear. Frequently they reacted violently to particular handling situations and threw themselves into obstacles. Of course, this meant that impact was harder.

As stated before, the laboratory research indicated that a high emotional state tended to lower bruise resistance. It may be that the pronounced difference in the bruise loss on the two types of animals, as indicated by this survey, was somewhat greater than it actually appeared. One of the test lots, consisting wholly of steers, turned out to be what is termed in the trade as a badly bruised lot. This particular lot showed an overall bruise loss of about $2.77 a head—just a little less than 3-1/2 times the average for all test lots of steers.

However, this badly bruised lot represented only 17 percent of the total number of steers included in the survey. This should mitigate the influence of this lot on bruise loss. While this lot was not typical, neither was it unusual, for such lots occur far too often. Packinghouse representatives indicated that while we ended up with one such lot out of 13, the average range of such lots in packinghouses was from 1 in 10 to 1 in 50.

In analyzing data on this test lot, we found the vast majority of the bruise injury occurred in the later handling phases. Therefore, handling and facilities during marketing and processing were largely responsible for the bruise injury. The condition that caused the loss was one which might well occur somewhat frequently at the particular plant.

Individual Test Lots

Discussions of bruise loss up to this point have dealt with a consolidation of results obtained in all 13 tests. There is much to be gained, however, in considering the results obtained in the individual tests, for they covered a wide range in economic loss. In the test used for illustrative purposes in the appendix, page 32, the bruise loss on that lot of animals was only $6.21 per hundred head. In the section of the report immediately preceding this one, we called attention to a test lot where the total loss was $276.87 per hundred head. A look at the results of the individual tests and a discussion of some of the factors involved in these tests will explain some of this wide range in loss. At the same time, they will indicate the importance of various factors in relation to these losses.

The results of the individual tests appear in table 3. Again, the figures have been converted to the 100-head basis. The total loss column of this table confirms the dramatic difference between the loss on the least damaged lot and that suffered by the one badly bruised lot. Three lots were also above the average of $60 per hundred head, while 10 lots fell below that average. Nearly half the lots suffered losses in the $25 to $50 range.

One important factor in the makeup of the total loss figure becomes apparent with a look at the trim loss figure. The badly bruised lot had a total loss approximately 46 times as great as the least damaged lot. Yet if we excluded this badly damaged lot from the trim loss, the highest loss due to trim-out would be only about five times that of the lowest. Even if we included the badly damaged lot in the trim loss, the difference would be about 13 to 1 rather than 46 to 1. Thus the devaluation loss, in reflecting the prevalence of severely damaged sides in a test, accounted for the great variance in the total loss figure.

A total of five different packing plants were involved in these tests. In some instances several tests were conducted at a single plant. The results obtained where more than one test at a plant was conducted were fairly compatible. Total loss figures applicable to the various tests at that plant were either high, low, or somewhere in the middle range. The badly bruised lot was the only one slaughtered at this particular plant, whereas, the low lot—the lot on which the total loss was only $6.21—was one

Table 3.—*Bruise loss per 100 head by test lots*

Test number	Number "trim" bruises	Number "fire" bruises	Pounds trim tissue	Financial trim loss	Devaluation loss	Total financial loss
Test 1	28	13	21.4	$15.04	$ 30.96	$ 46.00
Test 2	36	71	22.0	14.06	9.00	23.06
Test 3	40	133	17.3	10.13	20.88	31.01
Test 4	44	116	28.4	15.03	14.90	29.93
Test 5	40	87	38.7	22.89	51.73	74.62
Test 6	46	100	28.4	15.14	0	15.14
Test 7	53	168	17.9	10.71	15.85	26.56
Test 8	54	96	14.4	6.21	0	6.21
Test 9	81	103	35.6	16.58	0	16.58
Test 10	176	115	58.5	30.44	77.92	108.36
Test 11	144	89	38.7	18.44	11.80	30.24
Test 12	100	60	37.1	18.04	23.38	41.42
Test 13	177	64	157.5	82.31	194.56	276.87

of two lots slaughtered at another given plant. The loss on the second lot was also quite low.

All of this indicates that packinghouse facilities and handling at the packinghouse had a significant influence on bruise loss. The record of potential bruise-causing incidents occurring in the various tests and the correlation of those incidents to the bruise record substantiates this. Most of the identified bruises occurred during the pre-slaughter and post-slaughter phases at the packing plant.

Plants with the highest total loss had the most awkward and complex facilities and handling, in general, was rough. Likewise, the plant where the lowest losses occurred—referred to in the appendix, page 32, was the plant with the simplest, most practical and smoothest operating facilities, and the handling was uniformly good.

During the other handling phases such as loading, unloading and yarding, some test lots received higher percentages of bruise loss than did others, but the difference was not too great.

While it seems fair to give considerable weight to the influence of packinghouse facilities and handling to total bruise loss, other factors beyond the control of the slaughterer may very well have been responsible. Here we are thinking in the terms of variations in grade, variations in resistance to bruise injury, and other such factors.

The principal reason for discussing the individual tests is to stress the many factors involved in bruise loss. An average figure is only a general indication of such loss and may have little or no application to the situation prevailing at a given facility. This problem will be discussed in greater detail in a later section of this report dealing with general implications of the survey.

Carcass Grade

People in the livestock industry have generally held that bruise injury and the consequent financial loss were closely related to the grade of the animal. They felt that cattle in the prime or top choice grades usually had considerably less carcass bruise damage and subsequent loss than those grading lower—standard, commercial or utility.

They reasoned that the higher graded animal had the advantage of a protective layer of fat which served as a cushion when impact occurred. This, in turn, meant that light impact would probably do little more than rupture blood vessels in the fatty tissue and result in a fire bruise. In the lower graded animals with no fat covering impact would result in a damage to the muscle tissue. This was the case in the laboratory research referred to earlier.

For this reason, we included test lots of animals representing the various grades. We experienced some difficulty in setting up a sample on this basis since packers usually purchased the lower grade animals on the open market rather than direct and, as previously noted, it was necessary that directs be used in this survey. Although the majority of animals in these various tests fell in the choice or top good grade, a sufficient number of other cattle were included so that the tests actually covered animals grading from low prime to commercial.

Although actual packer grades were obtained on all carcasses of test animals (that is, the various USDA grades were broken into top, medium and low), consideration of bruise loss as related to

carcass grade was confined to the broad USDA terminology in the following analysis. Actually only three of these broader grades were used: choice, good and standard. Since most of the animals fell in these three grades, we decided they were sufficient to provide a representative sample.

The survey data for bruise loss on the basis of carcass grade is presented in table 4. A quick glance at the total loss column confirms the belief of the livestock industry that there is a special relationship between carcass grade and bruise loss, for the financial loss is progressively higher as grade decreases.

If the total trim weight was the same in all grades, the resulting financial loss would be higher for choice cattle than for standard cattle because choice cattle might be bringing 40 to 45 cents a pound, whereas standard cattle might be commanding only 34 or 35 cents. But table 4 shows that at even considerably lower prices for the lower grade, the overall loss figures are much higher than for the best grade—choice. This, of course, indicates that the bruise damage itself—trim loss and devaluation loss—was much higher for the plainer and lower grades.

Perhaps a better way to consider the likelihood of carcass bruise injury is to ignore the financial factor altogether and look at the various grades on the basis of total number of trim bruises, total number of fire bruises, and the trim weight. If this is done, virtually the same picture is obtained. The total number of bruises requiring trim was progressively higher as the carcass grade fell. Choice cattle had only about two-fifths as many trim bruises as did standard cattle. While the variation insofar as fire bruises was concerned was not so great, the same pattern prevailed.

This is also true if weight of trim is considered except that there was little difference in the trim weight between good and standard grade carcasses, but almost twice as much trim as between good and choice. One reason for the much higher trim weight in the lower or plainer grades of cattle has already been mentioned. These plainer cattle had less protective fat covering and, hence, bruise injury was more apt to be in the muscle tissue which requires trim. In fancy cattle, choice or prime, the impact which caused the trim bruise in the plainer grades might easily have produced only a fire bruise in these higher grades.

Still another way of comparing the liability of bruise injury on a carcass grade basis has been introduced in table 4 by a column headed "Number of head bruise free." This column shows that in a given lot of 100 head of cattle a certain number could be reasonably expected to show up in the packinghouse cooler without trim or fire bruises.

When we look at the figures in this column, virtually the same picture is

Tabel 4.—*Bruise loss per 100 head by carcass grade*

Grade	Number "trim" bruises	Number "fire" bruises	Pounds trim tissue	Financial trim loss	Devaluation loss	Total financial loss	Number head with no bruise loss or damage
Choice	56	85	26.6	$14.57	$14.14	$28.71	36
Good	96	102	58.8	31.04	55.50	86.54	26
Standard	141	110	54.1	28.60	72.46	101.06	15

presented as when the figures in the total loss column and the various bruise columns were considered. Here considerably larger number of choice grade than plainer grade cattle came through bruise free. More than twice as many choice as standard cattle and a little more than a third more choice than good came through bruise free. All in all, there seems ample evidence that bruise incidence and bruise loss have a positive relationship with the grade of the cattle.

Perhaps the best lesson that can be learned from a study of the information in table 4 is this. Even though plainer grades of cattle cost less and sold for less, the increase in bruise damage was such that the financial loss was considerably out of proportion to the investment involved when compared with fancier grades. Those in a position to be affected by this loss should give considerably more attention to safe, sane handling of lower or plainer grades of animals.

Location in Truck

During the loading of animals into the motortruck we made a record of which end of the truck the animals finally were transported in—whether they rode in front of the divider or behind it. We wanted this information because animals that moved past the divider and rode in the forward end of the truck had to negotiate a narrow entrance way. Thus they were more likely to suffer some bruise damage from impact of some part of the body with the sides of this narrow opening.

Most of the test lots were moved in trucks with center dividers of various types. Some were permanent with a narrow gate at one side. Others were movable and could be swung closed after the animals were herded into the forward end of the truck. In this latter case, the injury likely to be sustained was lessened because only those animals apt to be struck by the divider when it was closed would be affected. With the permanent type divider, each animal entering into the forward portion of the vehicle was exposed to likely bruise damage.

The overall bruise loss was somewhat higher on those animals transported in the rear of the truck rather than those in the front. This would indicate that this extra exposure to potential bruise injury insofar as the divider is concerned was not a factor.

However, a better measure of the influence of this particular type of hazard can be gained by a closer inspection of the unidentified bruise record. The percentage of unidentified trim bruises was about the same for each of the two groups, but in the case of fire bruises, animals moving in the front section of the truck sustained approximately 10 percent more unidentified fire bruises than those moving in the rear.

This may be considered as some evidence of the potential bruise-causing effect of the divider. No conclusive evidence was obtained, however, in this test to indicate that the hazard factor of this particular facility was such as to single it out for particular criticism or to regard it as a major factor in bruise injury and loss. Even if the divider resulted in some bruise injury, its use could well prevent more serious injury from happening. If the divider were not there, animals might crowd into one end of the vehicle which could well result in one or more of the animals going down. This, of course, might produce extensive damage.

Handling Phase

Relating bruise injury to the various handling phases was the most important single part of the survey. This is true because the "how and why" of bruise injury could best be established by this technique. If there is to be any substantial reduction in bruise loss, this how and why must be established in order to devise ways and means to correct loss-causing situations.

As previously pointed out, the entire time that the cattle were in the marketing and processing steps was divided into four major handling phases—loading, unloading, yarding and slaughter. The exact point at which one phase began and ended is illustrated in the detailed test described in the appendix, page 45.

We kept the record of potential bruise-causing incidents occurring to each individual animal by handling phase and carcass location. The record of actual bruise damage, of course, was by carcass location alone. The relationship between the two was established by comparing the actual carcass damage record with the potential injury record. If the carcass injury was at the same point on the animal where a potential bruise-causing incident occurred during a given handling phase, we assumed that the incident bore a relationship to the damage.

Likewise, in those instances where there was no carcass damage and no record of potential bruise-causing incident, what might be termed "compatibility" between handling conditions and practices and carcass condition was also established.

In this survey we obtained a degree of compatibility of about 70 percent. This meant that the potential bruise-causing incident record was in accord with the actual carcass damage record almost three-fourths of the time. In those cases, there was no record of a likely injury-causing incident and no record of carcass damage, or else there was carcass damage which could be related to a potential bruise-causing incident.

The record of all tests also showed that about 50 percent of all bruises requiring trim were positively identified. These identified bruises accounted for 56 percent of the trim weight and 58 percent of the trim value. In addition, 70 percent of the devalued sides were identified, and these represented 72 percent of the total devaluation loss. Overall, approximately two-thirds of total financial loss due to carcass injury (bruises) was identified. The highest degree of identification was in the case of hip injuries (loin bruises) and the lowest applied to rib injuries.

In arriving at the degree of compatibility, we decided any questionable instances on a conservative basis and resolved them in the favor of non-compatibility. In addition, in a few instances during the survey conditions arose that resulted in inability to record potential bruise-causing incidents that were observed. This, of course, caused some deficiency in this segment of the record, and probably resulted in a lower degree of identification and compatibility than would have been the case if this record had been complete.

It was never anticipated that 100 percent accuracy could be obtained in these tests since the conditions under which they were conducted were far short of laboratory controlled conditions. The sacrifice of accuracy is believed justified in view of the significant contribution made by conducting the tests under conditions ordinarily prevailing in the handling of livestock.

Table 5 shows results obtained on the basis of relationship of bruise damage to various handling phases. Again, this is on the basis of theoretical 100 head lots. Totals in table 5 for each of the various carcass locations, as well as the total for the entire animal differ, somewhat from similar figures appearing in table 1. Circumstances during some of the tests were such that although accurate records of actual carcass injury could be obtained, the record of potential bruise-causing incidents in the various handling phases was incomplete or blurred.[5] Therefore, these particular tests were omitted in compiling the data in table 5.

Essentially, where any question of reliability of the record of potential bruise-causing incidents existed, these tests were thrown out of the tabulation contained in table 5 in order to insure fairness to the cooperating parties and to maintain the highest degree of reliability possible. Actually, only two tests

Table 5.—*Bruise loss per 100 head by carcass location and handling phase*

Carcass location and handling phase	Number "trim" bruises	Number "fire" bruises	Pounds trim tissue	Financial trim loss	Devaluation loss	Total financial loss
Hip						
Loading	4	4	3.1	$2.10	$2.24	$4.34
Unloading	2	1	2.5	1.77	5.98	7.75
Yarding	([1])	1	.2	.11	.32	.43
Slaughter	11	12	7.1	4.77	8.04	12.81
Rib						
Loading	1	([2])	.2	.12	0	.12
Unloading	1	([2])	.2	.11	0	.11
Yarding	0	0	.0	0	0	0
Slaughter	1	3	.6	.36	1.29	1.65
Shoulder						
Loading	2	2	1.1	.44	1.02	1.46
Unloading	1	1	.5	.23	0	.23
Yarding	([2])	([3])	.1	.06	0	.06
Slaughter	11	8	5.6	2.25	2.08	4.33
"Other"						
Loading	([3])	([3])	.1	.02	0	.02
Unloading	([2])	0	.1	.06	0	.06
Yarding	([2])	1	.5	.28	0	.28
Slaughter	7	10	3.7	1.66	8.46	10.12
Total carcass						
Loading	7	7	4.5	2.68	3.26	5.94
Unloading	5	2	3.3	2.17	5.98	8.15
Yarding	1	2	.8	.45	.32	.77
Slaughter	30	33	17.0	9.04	19.87	28.91

[1]One in 1,000 head average.
[2]One in 250 head average.
[3]One in 500 head average.

[5]The principal cause for incomplete or blurred records, insofar as potential bruise-causing incidents are concerned, was due to the failure of portable tape recorders to function properly during certain of the handling phases.

were deleted, but one of these test lots happened to have a relatively high bruise loss. This loss is reflected in the higher loss figures shown in table 1, as compared to the figures in table 5.

Gross total figures in table 5 show that most of the identified bruises were related to the slaughter phase. In other words, this phase accounted for the largest number of trim bruises, the largest number of fire bruises, the most pounds of trim tissue, the highest trim loss, the largest devaluation loss, and the greatest total loss. However, we should emphasize these are gross figures and not precise measures.

Loading appeared the second most costly phase of all of these categories, except for devaluation loss and total loss, where the unloading phase ranked second.

It was somewhat surprising to find that the bruise loss associated with handling during yarding was extremely low. However, subsequent checks referred to earlier in the report indicated that this figure was not very much out of line.

If we look at these overall figures from another viewpoint, the majority of identified bruise loss occurred after the cattle were in the hands of the final buyer. The loss at this point was approximately double the loss during the time the animals were in the hands of transporters and marketers.

But it is well to examine the data in table 5 by carcass location of bruise injury because the proportionate "share of responsibility for damage" is somewhat different than for total figures. Further, the reason for the high losses in the slaughter phase can be better pinpointed—at least so far as carcass location is concerned.

While the slaughter phase accounted for approximately twice as much of the identified bruise loss on a total basis as did the other handling phases, losses from hip injuries were about equally divided between the slaughter phase and all other phases.

On the other hand, losses in the carcass category "Other" were just under 300 times as great for the slaughter phase as for other handling phases. The probable reason for the almost equal division of losses in the hip loss category was that during all of the various handling phases hips were particularly vulnerable to bruise-causing incidents. But it was only during the slaughter phase that the backs of cattle were particularly susceptible to bruise injury. The majority of trim bruises, and consequently trim weight and trim loss contained in the "Other" category, were in the form of back bruises.

During the slaughter period the animals were much more closely confined. As they moved along in the slaughter process, handling procedures often resulted in bruising their backs. For example, normally catwalks traversed the entire distance from holding pens adjacent to the kill area to the knocking box, and the driver was, therefore, stationed above the animals. In using persuaders he naturally struck the animal across the back.

In addition, the majority of gates and partitions along this route were of the descending type and, frequently, struck the animal across the back when being closed. Still other back bruises which might be related to this slaughter phase were caused by animals riding across the back of one another as they proceeded single file through the narrow passageways characteristic of this handling phase.

While the figures contained in table 5 do not include unidentified bruise injury, the identified bruise pattern may well apply to a rather substantial portion of those bruises not identified. Some of this unidentified bruise loss may also have occurred immediately before the time the animals came under observation. This would be particularly true if a great deal of sorting took place during the time the animals were being assembled for shipment. Frequently this sorting was done by the "gate method," which can easily result in carcass injury when the sorting is hurried and the gate carelessly used.

At least some part of the unidentified bruise loss occurred during the time the animals were in the vehicle being transported from ranch or feed lot to destination. Naturally, animals did not stand stock still all of the time. During the journey some of them struck one another or the sides of the vehicle with sufficient force to result in some sort of carcass damage.

Observations made during the survey indicated about one-fourth to one-third of the unidentified bruise loss should be attributed to sorting before loading or to conditions and happenings in transit. This would make these two phases responsible for from 12 to 16 percent of total loss.

Relationship of carcass damage to various handling phases was not the same in each one of the tests. While a larger number of actual bruises requiring trim and fire bruises were always associated with the slaughter phase in each test, the severity of these bruises, as represented by trim weight, trim value, and devaluation loss, differed rather widely. For example, in one test 52 percent of the identified loss occurred during the loading phase, whereas in another test 81 percent of the identified bruise loss occurred during the slaughter phase. In all of the various tests, however, losses attributed to the yarding phase were low.

Of course, such things as cattle grade had a bearing on the different results obtained in the various tests insofar as bruise loss was concerned, but these other factors had little or no relationship to the incidence of loss in various handling phases. However, these variations pointed strongly to the influence of particular facilities and to handling which occurred during the various phases in the different tests.

In other words, rough handling and complicated or poorly engineered facilities often caused more bruise injury and bruise loss. This was borne out in the various tests conducted as a part of this survey. Where facilities were complex, as in slaughter plants, a high degree of relationship between bruise loss and that handling phase was established. Likewise, where rough handling occurred during loading or unloading, the bruise loss went up.

In evaluating the results in table 5, it becomes important, therefore, to look upon the figures as gross indicators of conditions existing on an overall basis in the survey and not as precise measurements of what degree of responsibility could reasonably be assigned to any given handling phase on a general basis. However, the survey involved a sufficient number of tests and a sufficient number of different facilities in all phases to justify the results as gross indicators.

Causes of Bruise Loss

The preceding section of this report presented data on the extent of bruise loss and damage which occurred during the various tests of the overall survey. These data were correlated on the basis of carcass location, type of animal, individual tests, carcass grade, location in truck and handling phase. Although some reference has been made to causes or factors which might affect the indicated bruise loss, no real discussion of these matters was presented. Actually, the references previously made were given primarily to clarify or further explain the bruise loss data.

It became apparent during various tests that certain handling conditions and practices did, in fact, have an extremely close relationship with carcass injury. The major purpose of this research project was to relate these to carcass injury. So throughout the entire survey every effort was made to accumulate information which would establish this relationship.

Before turning to a detailed discussion of the causes of bruise losses, one important point should be made. All the causes of carcass injury and subsequent bruise loss could, and did, occur during all phases of handling. Some were of a greater importance during one particular handling phase than during another. Nevertheless, the following broad categories of causes of bruise loss at all phases were found: (1) animal characteristics; (2) facilities; (3) handling techniques; (4) handler's actions and attitudes; and (5) miscellaneous factors (weather conditions, length of haul, and time in stress conditions).

Animal Characteristics

Bruise loss data in the previous section of this report indicated the influence of type and grade of cattle on subsequent bruise loss. Animals whose carcasses graded out lower were more susceptible to bruise injury. Likewise, steers appeared more susceptible than heifers. Therefore, class and grade must be considered as affecting bruise loss, but within a given class and grade, other animal characteristics or animal conditions had positive bearing on the injury sustained.

We have already referred to the variation in bruise resistance that exists in cattle. This bruise resistance was influenced by previous bruise injury and by introducing certain chemical compounds into the system. Certainly, the inherent bruise resistance of a given animal, regardless of the reason for this resistance, must be considered as a factor affecting bruise loss in these particular cattle.

Research showed that the emotional state of the animal was also closely associated with bruise susceptibility. The possibility of bruise loss is greatly increased with highly excited animals for they are not easily controlled. They become somewhat frantic, which usually results in a considerably higher number of impacts.

Couple this with the established fact that this emotional state also lowers bruise resistance and it is easy to see why in such situations these animals suffer higher bruise injury. This was borne out in certain of these tests. On two occasions, animals became unusually excited and fractious during the loading operation. In each case, there was an increase both in the number of potential bruise-causing incidents in this particular handling phase and in the number of trim and fire bruises on the

carcass which could be traced to this loading phase.

Likewise, the high incidence of bruise damage associated with the slaughter phase could well be related to the emotional state of the animal since at this point operating conditions frequently resulted in exciting the cattle.

Perhaps one of the most positive pieces of evidence obtained on the relationship of emotional state to bruise injury occurred in one test. The animals were left alone during the slaughter phase and more or less moved themselves through the narrow passageways and into the knocking box. No one was there to drive them, no persuaders were used. In fact, the animals' natural curiosity and "follow the leader" instinct brought about this quiet movement during the slaughter.

When the bruise results of the tests were accumulated, we found that this particular group of the test lot suffered little or no injury which could be connected in any way with the slaughter phase.

The general health of the animal may also have some bearing on the likelihood of its suffering bruise injury. Weak animals, crippled animals or those with lowered resistance are highly vulnerable to such injury. These animals frequently went down during transit and even during the slaughter operation. They were, of course, then trampled on and required some rather vigorous action on the part of handlers to get them up and move them along.

At least two animals in the tests could be characterized as not being in good health. Both of these animals fell during the various movements of the handling and both animals sustained a high degree of carcass damage. In fact, of the four sides involved, three had to be subsequently devalued because of carcass injury.

In addition, a higher degree of bruise loss on other animals in the lot occurred than normally would be expected. Some of this could well be attributed to the fact that when the weak animal went down in the vehicle, the other animals in the load became confused. Considerable pitching and tossing caused impacts of such a degree that bruise injury was likely. The presence of a weak or crippled animal in any lot increased the likelihood of bruise injury to the entire lot, as well as to the animal itself.

Of course, anyone who found it necessary to ship a crippled animal or one not physically strong had it within his power to isolate this animal from the rest of the lot, both as a protection for the distressed animal itself and for the rest of the animals in the load. Certainly, most packers recognized this, for cripples or weak animals were usually slaughtered separately and not subjected to the usual conditions prevailing on the normal slaughter line.

While some of the animal characteristics mentioned above lay beyond the control of human beings, some of these characteristics could be controlled, at least to some extent, by handlers. This was particularly true insofar as the emotional state of the animal was concerned. The handler was in position to conduct his work in a manner which could either raise or lower the emotional pitch. If he realized that new and somewhat strange surroundings confused and disturbed the animal and, at the least, created a sense of uneasiness, he would know that his own techniques could do much to allay these fears and provide for safe handling.

Facilities

In discussing the influence of various facilities on bruise injury, we are referring to the permanent or semi-permanent structures and layouts in the various handling phases.

More specifically, we are talking about such things as corrals, holding pens, loading chutes, receiving docks, scales, stockyard alleyways and pens, and the layout and equipment used by packinghouses in the slaughter process. We also included vehicles used to transport animals.

Certain facilities appeared in one form or another in more than one handling phase. For example, there were holding pens at feedlots, in stockyards, and at packing plants. Likewise, there were loading or unloading chutes at all three of these points. On the other hand, some of the facilities were peculiar to a single handling phase. For example, knocking boxes and spray pens were peculiar to packinghouse slaughter layouts.

Almost any of the above mentioned types of facilities was different. That is, the lack of uniformity in construction, size and operation was bewildering. In fact, a detailed description is almost essential to make it absolutely clear just what a given facility was like.

For example, the term "loading chute" is almost inadequate. True enough, most loading chutes had similar appearance, but the similarity ended there. To aptly describe such a facility, we would have to give width, length, height of sides, degree of incline, type of incline and so forth.

This lack of uniformity makes a discussion of the influence of facilities on bruise loss quite difficult. Thus the following discussion treats each of the facilities in a rather general way. We paid particular note to the more common characteristics each of the different types of facilities possessed. In some instances, we noted the more unusual type of a facility if it appeared to have a closer relationship to bruise loss, good or bad.

Much has already been said of loading chutes without attempting to give "perfect" or "ideal" specifications. A good loading chute had at least two essential characteristics: (1) it was only wide enough to allow a single animal to pass through it comfortably; and (2) it was so constructed that the animal could not be diverted by happenings taking place on either side of the chute during the time that he was moving through it. If the loading chute was too wide, two or more animals could enter or attempt to enter at the same time, resulting in a wedge. The greater width could also enable an animal to attempt to turn around in the chute, which could also result in a wedge. Both of these situations resulted in bodily contact with the sides of the chute and if the wedge was tight enough, bruising could well result. Evidence of this was obtained in some of the tests in this survey.

Construction to prevent the animal from observing happenings going on alongside the chute was desirable. Even relatively insignificant happenings distracted the animal and caused it to stop its forward movement. This sometimes resulted in a traffic jam, requiring at the very least the use of a persuader to start the animal. This, of course, invited the possibility of additional carcass injury.

In addition if one came to an abrupt halt, pile-ups and confusion resulted. There was likelihood of widespread bodily

impact on several animals and, of course, increased bruise damage.

Where it was necessary for animals to go up an incline to enter a vehicle, this incline was usually a part of the loading chute. Stair steps had some advantage over rampways or cleated inclines. Of course, good footing must be an integral part of the chute. If the animal falls, it is almost impossible for him to avoid contact with one or both sides of the chute, and the impact may be sufficiently severe to result in bruising. If the chute is used for both unloading and loading, the necessity of having a small area at the top of the chute which is level and straight is quite apparent.

Animals unloaded from vehicles onto loading chutes which began with stair steps or rampways not only had great difficulty in maintaining footing, but fell frequently. In addition, animals exhibited a certain wariness when confronted by such situations and, frequently, it was necessary to provide excessive encouragement. Higher bruise loss, therefore, resulted both from the spills and falls and from the use of persuaders directly. Persuaders also caused animals to become fractious and strike themselves against the doorways of the vehicle.

What has been said about the width of loading chutes is equally applicable to other situations where animals can best be handled single file. In particular, it would apply to packinghouse slaughter areas. Where long, narrow alleyways led to slaughter facilities, there was considerably less confusion, and less bodily impact. Also less bruise loss showed up on the carcasses.

Of course, alleyways moving through stockyards or through large outside holding areas did not have to meet this requirement. In fact, they seemed better if they were wide enough for several animals to move abreast. The principal consideration in a case of this type alley (stockyard alleys and so forth) was that they be free of obstacles, whether on their surface or along the sides.

Protruding posts, partially opened gates, and gate fixtures set out into the alley were responsible for many of the potential bruise-causing incidents during yarding. Although the alleyway may have been straight and wide, such obstacles were almost always responsible for some bruise injury, regardless of how carefully the animals were handled. In other stockyards, where these conditions

Cattle moving through stockyards often face bruise hazards. Note the "pocket" caused by the half-open gate and the obstructions protuding along sides of the alley.

did not exist, animals moved through the yards virtually "bump free."

Gates and partitions were, of course, a very essential part of all of the facilities listed above. Whether or not they exerted any influence on bruise loss was primarily determined by the manner used. If left partially open, forming an obstruction, they increased bruise loss. If swung too carelessly so they struck an animal, they influenced bruise loss. But if used carefully and judiciously, they could actually reduce likelihood of injury.

Partitions, or gates serving as partitions, frequently prevented overcrowding at various points during the handling phases. During the slaughter phase, this partition prevented animals from turning back or backing out of passageways, actions that could result in tripping and falling or cause other situations sometimes resulting in greater bruise injury. Of course, sharp corners, protruding nails, splintered boards and the like should not be tolerated since each of these could result in carcass damage.

The use of given facilities was just as important as the construction of the facility itself. No matter how sound and well a gate was constructed or how perfectly it was stationed along an alleyway, throwing it into a hip of a passing animal still resulted in serious loss.

Perhaps one of the most important considerations with facilities is that they be kept as simple and uncomplicated as possible. We have already referred to the fact that packinghouses with relatively simple kill floor layouts had the lowest identified bruise loss attributable to handling during the slaughter phase. Simple layouts are particularly important at the packinghouse. The situation here is one of limited time for handling and by its very nature, is especially bewildering, confusing and excitement provoking from the animal's standpoint.

When we speak of simplicity of layout, we refer to alleys and passageways which had a more or less natural sequence. Once an animal entered, it proceeded voluntarily in the proper way.

Sharp turns, followed by extremely short straightaways and succeeding sharp turns were confusing. Some of the labyrinths bordered on the fantastic. Animals were started in one direction, made a virtual U-turn, proceeded 50 feet, made another U-turn, and then after another 25 or 30 feet were called upon to make another U-turn. Put such a layout in use in a situation taut with tension and excitement and it is obvious that animals will become frightened. Impacts will occur which can result in increased bruise loss.

From the time an animal is taken out of his familiar pasture or feedlot until dispatched at the slaughter house, it faces strange surroundings and situations. If these situations are kept as simple as possible, there is the least likelihood for confusion or bewilderment. Carcass injury is bound to be lessened.

Insofar as facilities to transport animals are concerned, this report can touch briefly only on the motortruck since this was the only type transportation involved during this survey. Use of interior dividers or partitions in separating semitrailers into two compartments posed the likelihood of additional bruise-causing incidents. Data obtained indicated some additional injury did result from bodily contact with these dividers. Results showed that where partitions are used, extra precaution should be taken in loading and unloading to minimize excitement and to allow animals to pass through the

narrow openings, in a manner to reduce the possibility of impact.

Perhaps the most important feature of motortrucks, insofar as bruise loss was concerned, lay at their back door. The ordinary vehicle used to transport livestock had a very narrow end gate or exit. Unfortunately, it was frequently framed with sharp open angle irons or channelways. The majority of potential bruise-causing incidents which occurred during loading and unloading happened when animals were actually passing through this doorway. At this point impact frequently occurred, particularly if the animals were moving too rapidly or tried to crowd through more than one at a time.

Some few trucks had narrow end gates framed by rounded or cushioned panels. In these cases, while there were almost as many "bumps" sustained, the number of fire or trim bruises associated with these bumps was negligible. This would indicate that sharp corners on any facility are particularly hazardous and closely related to severe bruise damage.

Improper loading, as typified by overcrowding or loading so loosely as to allow for shifting, was closely related to bruise loss. In both of these situations, the possibility of impact was greatly increased.

This was particularly true in the case of overcrowding. When this condition

Narrow tailgates on trucks are a critical factor in bruise damage. The sharp channel iron and overlapping slats can inflict severe damage when an animal bumps against them. Obviously, "hurry" is out of place here.

existed, animals frequently fell during transit, with resultant trampling. In addition, when the time came to unload, jamming increased at the rear exit. This, of course, resulted in heavy impact of shoulders and hips with the sides of the narrow end gate.

Good footing is of particular importance in trucks. Animals not only have to acclimate themselves to confined areas and new surroundings, but they must become accustomed to the sense of motion. Many commercial livestock haulers started out the journey at relatively low rates of speed. This practice helped reduce the likelihood of carcass injury, for animals gradually became used to the motion of the vehicle and thus remained calm. They had an opportunity to catch on to the technique of maintaining footing in a moving vehicle.

Handling Techniques

This section on handling techniques and their relationship to bruise injury emphasizes methods and procedures used in moving livestock through the various handling phases. Handler's attitudes and actions will be discussed in the next section.

The techniques—the methods and procedures—are usually closely related to the various handling phases—for example, certain loading techniques, unloading ones, and those applying to various steps in yarding and the like. In general, all of the techniques have as their objective the orderly and expeditious movement of livestock safely through a given handling phase. Some of the techniques accomplished this objective with considerably less risk of carcass injury than did others.

The observations which follow come from experience gained during the survey, buttressed by an analysis of the potential bruise-causing incidents and of the actual damage found on the carcasses of the test animals.

One example of a handling technique which involved a certain amount of bruise hazard was the "gate method" of sorting. Actually, if this technique was properly executed, the potential bruise-causing happenings could be few. Nevertheless the nature of the procedure itself required that it be recognized as a potential cause of bruise loss.

The loading operation, as usually practiced, involved starting the animals up the loading chute and then getting behind the cattle and providing whatever amount of encouragement that was necessary to keep them moving. Actually, this technique often failed because the encouragement was often applied to those animals not responsible for the hold up.

A better technique was to apply the encouragement at a point nearer the entrance to the vehicle itself, usually where the slow down occurred. Frequently an animal already in the loading chute decided to stop. If there were 12 or 15 animals in the lot and the driver was standing behind all of them hitting the rear animals across the rump, he did not have very much effect on an animal standing virtually at the door of the truck, maybe 10 or 15 feet away from him.

On the other hand, a light tap with the persuader on the animal which had stopped could cause it to move forward and into the vehicle, thus removing the blockade and restoring an orderly flow of movement. The usual technique of applying encouragement at the tail end of the line often resulted in milling and confusion and subsequent carcass damage.

When animals were unloaded from trucks, some drivers practiced an effective technique to reduce the possibility of bruise loss. The driver stood at the side of the rear door. If more than one animal attempted to come through the exit, he merely placed his hand in front of one of them. This usually caused that animal to step back and the likelihood of two animals becoming wedged in the doorway was averted.

Perhaps one of the most important handling techniques was that of providing animals with a measure of friendly handling before shipment to market or slaughterhouse. Frequently animals had been alone on ranches or in feedlots with little or no contact with human beings until the day arrived for their shipment. As a result, the appearance of a man was disturbing.

But if several days before shipment the producer had gone out and walked around among the animals and let them become accustomed to him, they were much easier to handle, less likely to become excited, and more willing to enter strange and unnatural situations. It was not necessary to move animals about during this period although moving them from one lot to another in easy, careful stages could be beneficial.

Test lots which received friendly handling when they were tagged went on to load much easier than other animals from the same group of cattle that had not received this handling since they were not included in the test lots. Records of bruise loss obtained from cooperating packers on these animals not in the test lots indicated that their bruise loss was uniformly higher.

Another handling technique that reduced the possibility of carcass injury was particularly useful during yarding operations. This technique involved what J. C. Rosse of Livestock Conservation, Inc., has aptly termed "allowing cattle to obey their 'follow the leader' instinct."

Observation of several thousand head of cattle moving through public stockyards, in various feedlots, and on several ranches, would appear to prove that cattle do have a "follow the leader instinct"—that there may even be some sort of social order among them. Where yarding was unhurried, one animal assumed leadership and the others in the lot then followed it along the way. This technique greatly reduced the use of persuaders and the necessity of any vocal encouragement. In turn, the movement of the cattle was much more orderly and considerably less likelihood of carcass injury arose.

This technique could also be used to a limited extent during the slaughter operations at a packing plant. Earlier in this report we illustrated a situation during one of the tests when animals virtually followed the leader into the passageways leading to the knocking box and into the knocking box itself.

But kill operations are usually on a schedule and it is somewhat more difficult to fully employ this loss-saving technique. However, many packing plants could make better use of the technique by making relatively minor changes in facilities adjacent to the kill area.

Handling technique during the slaughter process which had a significant bearing on increased bruise injury involved the use of knocking boxes large enough to hold more than a single animal at a given time. When two and sometimes three animals were placed in this small area, it was virtually impossible for the first animal stunned not to be trampled by the remaining animals. Those facilities which permitted only a single animal

to be loaded into the box at a time eliminated this hazard.

Unfortunately, many who handle livestock regard the use of persuaders as their principal handling techniques. Actually, this is not a technique, but it may constitute an integral part of a technique—such as in the loading phase described above. Judicious use of persuaders at the proper time may facilitate movement without causing injury. However, it is rarely possible to place a persuader in the hands of a human being with the certainty that he will use it judiciously or that he will select the "right time."

Recently, a great deal of attention has been focused on the use of tranquilizers to facilitate the movement and handling of livestock. Using these drugs is said to allay fear and excitement and to permit more orderly and safer handling. None of the test animals in this survey were treated with these drugs so it is impossible to make any comment or observations on their effect. But use of the drugs may be developing as a new handling technique. Using tranquilizers in livestock handling also indicates the significance of the emotional state of the animal as an effect on carcass injury.

Handler's Actions and Attitudes

The handler's actions and attitudes may well be the one cause that holds the key to reducing or eliminating bruise injury. Regardless of the excellence of facilities, the soundness of handling techniques, and the most favorable set of animal characteristics, disastrous bruise loss could occur if the men handling the livestock did not adopt the proper attitudes and actions.

For example, in the test described in detail in appendix, page 39, the packing plant had the most favorable set of facilities. Yet, it would have been entirely possible for the personnel responsible for moving the cattle through these facilities to have handled the animals in such a manner as to raise their emotional pitch to the frenzy level—resulting in milling and pitching—and thus have brought on severe impacts. They could have used persuaders in such a manner as to run up the incidence of bruise loss, particularly on the backs of the cattle. In such a case, the excellence of the facilities would have been completely nullified by the actions of the handler.

In some instances, the facilities were considerably less than excellent but the careful and considerate handling of the driver kept the animals calm. A minimum amount of potential bruise-causing incidents resulted. Hence a relatively low bruise loss was attributable to this handling phase.

Human conduct also affected bruise loss for good or bad in every handling phase of each test lot included in the survey.

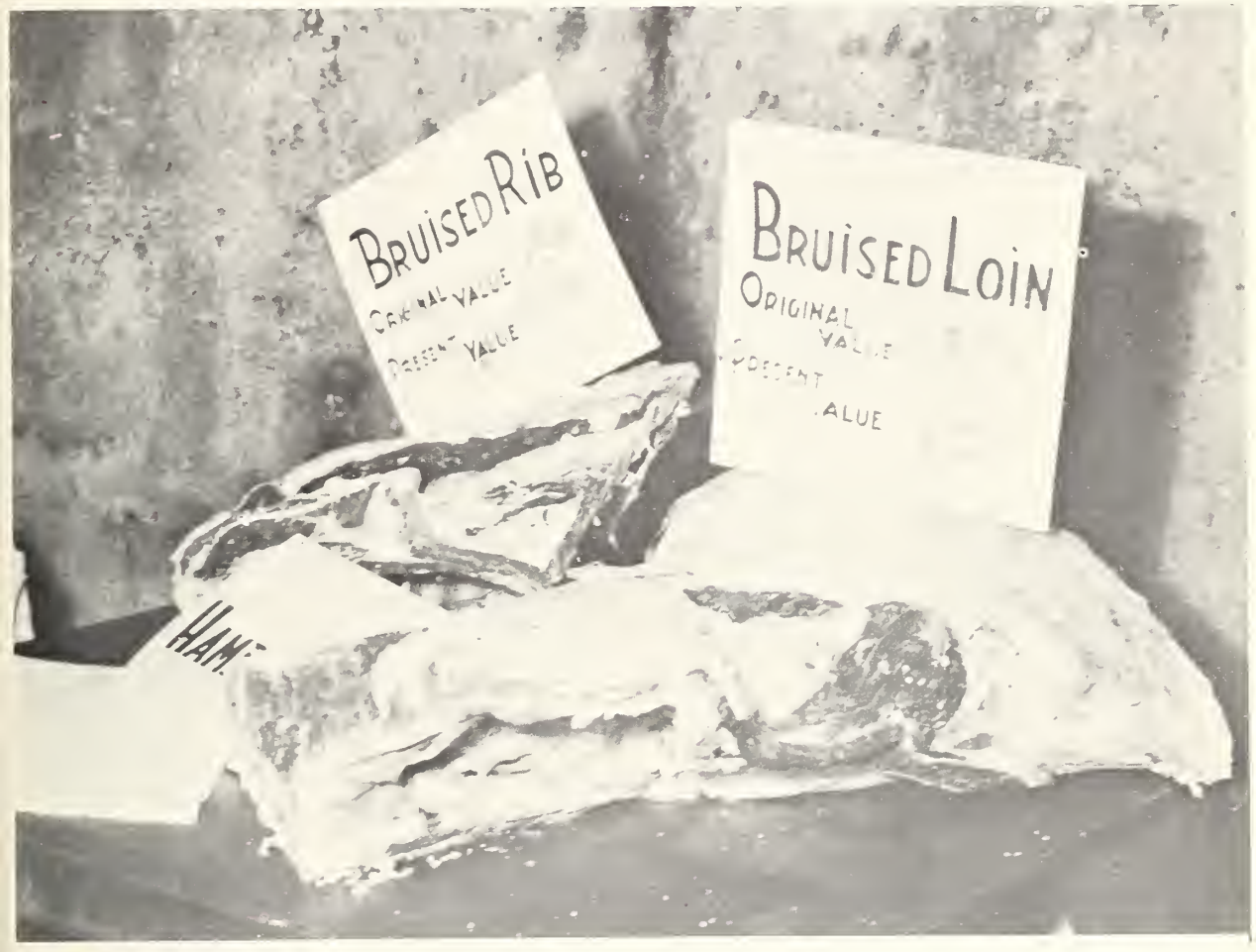
In general, handling accorded a given lot of cattle reflected to a considerable extent temperament and attitude of the handler at the time the movement was taking place. Ample evidence during this survey supported this statement. If for some reason the handler was in a petulant or angry mood, his treatment of the cattle was invariably rough or careless, or both. Likewise, handlers who appeared worried, preoccupied, or disinterested were careless. If things didn't go too well, tempers frequently exploded and rough handling ensued.

Of course, many things can affect temperament and attitude of a livestock handler—working conditions, outside factors of a personal nature, even such

things as the weather and the animals themselves. Handlers and their employers can minimize the influence of unfavorable temperaments and attitudes. First these people must be impressed with the effect their actions can have upon cattle in their charge.

An appeal can be made on the basis of economics, particularly on how carcass damage may affect income and profit and subsequently job security. Nothing can be lost by an appeal for humane treatment. The owner of livestock, whether he be producer or packer, can also insist on proper handling. By doing so he can bring about training programs and educational drives aimed at impressing handlers with the importance of their job. If it is within the owner's province, he can take corrective steps to guarantee such safe handling. After all, the man who owns the cattle is in the best position to deal with this problem.

Hurried handling was the largest single cause of bruises. A preceding section of this report described the handling technique of utilizing the "follow the leader" instinct. The livestock industry generally considers this technique effective in minimizing bruise loss. But the



These primal cuts emphasize the importance of careful handling. Here $18 has been lost through bruise injury.

technique cannot be used if hurry becomes paramount in handling. Not only did hurrying result in an increase in potential bruise-causing incidents but in many cases it retarded rather than facilitated handling. In effect it was self-defeating.

For example, when animals were unloaded from a vehicle, efforts to hurry them out of the truck by the excessive use of persuaders accompanied by loud voices usually resulted in confusing and exciting the cattle. Not only was there a marked increase in the number of bumps sustained but a considerably longer time was required to finally get all the animals out of the vehicle. Actually, if the driver was in a hurry, he would have better accomplished his purpose by taking his time.

There is no justification for hurrying on any basis. Facility in movement is desirable but this can be best attained by proper handling techniques. Even in the slaughter phase at packinghouses, where kill schedules are a matter of concern, safe handling techniques can better meet these schedules than can the intemperate handling which usually accompanies hurry.

Carcass injury from hurrying was likely to result in two ways. First, if the animals were moved too fast, they were likely to become unduly alarmed. More impacts of the animal's body with that of another animal or with a stationary part of a given facility could occur. Second, the ordinary method of hurrying animals with persuaders—frequently in an excessive and abusive manner—could cause bruise damage.

Miscellaneous Factors

Although weather did not appear as important with cattle as it was with other species of livestock, it exerted some influence on carcass bruise damage. For instance, precipitation could cause surfaces over which animals must pass to become slippery or slickened so it was difficult for them to maintain footing. Even under the most careful handling conditions, slips and falls were apt to occur and some carcass injury resulted. The only remedy was to spread the surfaces with materials that afforded better footing and to move the animals as slowly and cautiously as possible.

But the weather also exerted some influence on bruise injury in less obvious ways. Experienced livestock men have long contended that animals are sensitive to changes in the weather. When such changes are imminent or in progress, animals may become uneasy and fractious and difficult to handle. We found this to be the case in three of the tests in this survey.

Even though livestock men recognize the unsettling effect of changeable weather conditions, many of them select just this particular time to market cattle. While there may be times when this is justified, many might do differently if they became more fully aware of the relationship of bruise injury to the emotional upset of animals during these changeable weather periods.

Previous studies of Farmer Cooperative Service indicated that length-of-haul has a bearing on dead and cripple losses. Increased lengths-of-haul produced higher incidence of death and crippling. The same would probably hold true in bruise injury. Of course, a major consideration would be handling during the transit period.

Unfortunately, no test lots in this survey moved over distances of sufficient length to provide for an analysis

of varying lengths-of-haul. However, cooperating packing plants indicated some increase in bruise injury on those lots of cattle moved over extremely long distances. The frequency did not increase on anything like the scale for other species of livestock. This result agrees with the dead and cripple loss statistics compiled in the previous FCS studies.

One other factor of importance was related to the so-called "stress factor" in animals. It has already been observed that animals react to strange surroundings. Animal psychologists tell us that this results in a stress condition. This may be reflected in anxiety or uneasiness. These latter conditions have been found closely related to carcass injury and loss from bruising.

Other researchers have indicated that both length of time animals are subjected to stress conditions and what might be termed "the degree of change" involved affect the stress level. Thus if a shipment of cattle were subjected to unfamiliar conditions and if these conditions persisted over a greater period of time, likelihood of bruise injury would increase.

This problem can be met in three ways:

1. Friendly handling during the time animals are in unfamiliar surroundings would help calm them and allay their anxiety and fear.

2. Facilities should be constructed or adjusted to minimize complex movements in order to move the animals as naturally as possible. For example, loading chutes were often spread with hay and refuse when new. This cut down uneasiness on the part of cattle using the chute for the first time.

3. Handling during these periods of stress should be as swift as safety allows in order to reduce the time that the animal is subjected to the stress condition.

Some Implications of the Survey

Bruise loss is a major problem of the livestock industry, as data in this report show. Substantial savings could be effected if it were possible to reduce this loss. If we assumed that total loss were the same as the lowest bruise loss in this survey, bruise loss on a national basis would still be in excess of $1 million a year. If we use what appears a more nearly representative figure for rate of loss, this national bruise loss figure would be between $8 and $12 million a year. While the loss cannot be entirely eliminated, it can be substantially reduced, provided corrective measures are taken.

The survey showed that the industry was grossly underestimating at least one portion of the loss. We refer to trim loss. The majority of packing concerns, in calculating their own bruise loss figures, included only carcass devaluation loss, actually only about two-thirds of the total loss. Tests conducted as a part of this survey suggest that trim loss should be re-evaluated and properly considered as a loss factor. While some tests had no devaluation loss, trim loss occurred in all tests.

No single segment of the livestock industry can be saddled with full responsibility for bruise loss. Losses occurred during each handling phase in direct relation to the frequency and severity of potential bruise-causing injuries which took place. The tests showed that in

certain handling phases, which in turn represented various segments of the industry, the likelihood of bruise injury was greater than in other handling phases. At the same time, some tests showed that these more hazardous phases need not be responsible for the largest bruise loss, provided that judicious and careful handling coupled with efficient facilities prevailed.

The important point is that various factors could influence the bruise loss in any handling phase. Therefore, if conscientious efforts are made to control the bruise-causing factors, any segment of the industry can favorably alter its bruise loss pattern.

The industry needs to recognize that this is really an industrywide problem. Each segment must accept some measure of responsibility for it.

This survey clearly indicated that livestock can be handled safely through the various handling phases and end up as damage-free sides of beef in the packinghouse cooler. Combined results of all tests in the survey, without regard to type and grade of cattle, showed that about 30 percent of all test animals escaped bruise injury during handling from ranch through processing. Of course, this percentage varied from test to test. Significantly those tests where facilities were the best and where handling was uniformly good were the tests with the highest percentages of bruise-free carcasses.

The same conclusion that cattle can be handled safely can be justified on the basis of results obtained in any given handling phase as well as on the basis of all phases collectively. Although this record was much more favorable in certain handling phases, in each phase a substantial number of cattle were handled without suffering any damage. Therefore, the desirable goal of bruise-free livestock is within reach.

The survey also implies possibilities, if not ways and means, of reaching this goal. Basically, the goal can best be attained by control of bruise-causing factors, but at least three possibilities ought to be given special emphasis. Two are rather obvious, and, in most instances, would not require the expenditure of large sums of money or necessitate extensive research. Adopting safe, simple, "natural" facilities would enable handlers to take advantage of the best handling techniques and procedures. This could be a very effective means of reaching the goal. Likewise, promoting safe-handling programs designed to alert handlers to the relation of their actions and attitudes to carcass injury could do much to increase the number of bruise-free carcasses hanging in the cooler.

One other possibility is worthy of mention. While it may seem somewhat remote at the moment, it should not be dismissed too lightly. This has to do with the likelihood of raising the bruise-resistance of cattle. Earlier in this report we mentioned work done at Ohio State University that indicated bruise resistance could be increased by introducing certain chemical compounds into the system of cattle.

No doubt a great deal of research will be necessary before such compounds can be perfected to the point where they can be administered safely and easily and on an economical basis. But considering the strides made in r cent years in animal husbandry and veterinary medicine, we can assume that research to perfect the compounds will be forthcoming.

An added stimulus to this activity may well come from the pharmaceutical and chemical industries which have recently become active in the livestock field. The success these industries have had with systemic grubicides, antibiotics, feed supplements, and the apparent success they are going to enjoy with tranquilizers may well prompt them to expand their interests to the particular problem of raising animal resistance to bruising.

Appendix

The appendix is divided into two sections, one containing additional information on the bruise test for cattle in the market, and the other a description of an actual test.

Supplemental Information on Bruise Test for Cattle under Ordinary Market Conditions

Livestock moving from the producer through the processing plant ordinarily pass through many different hands. This presented a major problem in designing a test to study the relationship of bruises to handling conditions and practices. Good cooperation among the various handlers was absolutely necessary.

In the ordinary marketing of livestock, cattle usually would be handled by the producer, a transportation agency, a marketing agency, and a slaughterer. These are the very minimum, but it might well be that even more people would handle the cattle. For example, in the market, cattle might be received and handled by employees of the stockyard company, subsequently handled by employees of a commission firm, then handled again by stockyard company employees before being turned over to a packer-buyer.

In setting up the tests used in the Farmer Cooperative Service survey, we decided to confine the test lots to cattle which might be termed "directs"—those owned by the packinghouse before movement to slaughter. This meant that the cattle would be handled by a smaller number of people, particularly at the market. It is true that some direct shipments moved from the ranch or feedlot directly to a packing plant. But, in some instances, the stockyard company received the cattle for the slaughterer and, in those cases, animals were subjected to some of what might be termed "ordinary yarding procedures."

Another factor led to the decision of using directs. If animals consigned to a commission firm for ordinary sale were used, they might be purchased by someone off the market, or by a packer who had not been included in the cooperative test schedules. It was definitely advisable to eliminate this possibility of losing the shipment as much of the preliminary work and the observations made during that time would be of limited value in actually dealing with the problem.

The survey was conducted during the spring and fall of 1958, primarily in the Midwest and Rocky Mountain areas. Public stockyard companies in these areas cooperated and a sufficient number of packing plants indicated a willingness to participate in the tests. Previous studies by Farmer Cooperative Service and other agencies indicated that the weather factor is not as important with cattle as with some other species of livestock and, hence we felt it was not necessary to conduct these tests over a longer period of time in order to reconcile climate differences.

Instead, the principal factors thought essential were a sufficient number of

test lots and test animals to provide an adequate sample, a sample that would include various classes and grades of cattle, and an adequate number of packing plants and loading points to account or reconcile variations in facilities. We believe that the sample obtained and used in the survey adequately meets these criteria.

The basic premise in the tests is that bruises are caused by impact. The tests attempted to relate such potential injury-causing factors or conditions to carcass bruise damage. During the time that the tests were actually being conducted, they were referred to by those participating as "a bump-bruise" test.

Over a period of approximately 2 years before this survey, personnel of Farmer Cooperative Service did considerable experimenting in cooperation with the Omaha office of Livestock Conservation, Inc., in potential bruise tests.

In these early experiments, there was an attempt to tabulate the "bumps" cattle received in being loaded or unloaded into motor vehicles and in making various maneuvers through the stockyards. Once or twice, it was possible to obtain bruise loss figures on a given lot of cattle. In most instances there was no follow through to enable the experimenters to relate the bumps to the bruises. However, this early experimental work did much to develop the techniques used in this survey on a workable basis.

We decided that the most practical point to begin collecting potential bruise data during these tests would be the time the animals were loaded into a vehicle for transport to a market, and that the logical concluding point for the observations would be at the packing plant after the animal was dispatched. Such an arrangement had one serious weakness—it did not take into account any conditions which might have existed before loading time which could have resulted in carcass bruise damage.

Apparently the only way to have guaranteed that all carcass bruise damage occurred during the time the animals were under observation would have been to use animals that had been stanchion fed for a somewhat lengthy period of time prior to shipment. In this event, of course, we would have been returning to almost laboratory controlled conditions. In a survey of this type it would have been highly impractical, if not impossible, to establish such conditions in the field for use in tests designed primarily to consider happenings in actual transportation under ordinary conditions.

As a compromise, we made every effort to obtain test lots which had been on a well maintained and properly equipped feedlot for a minimum of 60 days before movement. This gave the animals time to recover from any bruise injuries sustained in previous shipment. Since the animals were on selected feedlots where conditions were more or less ideal, the likelihood of bruise injury would be minimized.

As a final check on prior bruise injury, we decided to apply the color test for age of bruise determination to some tissue samples obtained during the survey. We wanted to discern whether or not bruises caused while the animals were under observation were, in fact, of sufficiently recent occurrence to be properly associated with the potential bruise-causing incident. We also wanted to know that if they showed an older age when subjected to the tests, whether it would be proper to assert that the injury had not occurred while the animals were under observation. This was done on several occasions during the test. In each

instance, the selected bruise tissue, when subjected to the color test determination, proved a "fresh" or recent bruise.

In recording the potential bruise-causing incidents, we separated the total movement from ranch or feedlot through slaughter into distinct "handling phases." This was necessary first because an animal might sustain more than one bump at the same carcass location at various points and we needed to know at just what point in the movement the various potential bruise injuries occurred.

In addition, by dividing the total movement into specific periods, we could determine at just what phase or points the most of the carcass bruise injuries were being sustained. Therefore, we maintained the record of bumps or potential bruise-causing injuries on the basis of: (1) carcass location; (2) handling phase; (3) type of cattle; (4) grade and (5) a category which dealt with the degree or estimated degree of impact.

We also noted unusual conditions likely to produce injury. For example, an animal slipping and falling would likely suffer bruise injury. An animal which banged into the side of a fence post when moving along an alleyway also might be injured. Likewise, persuaders were sometimes used in such a manner that carcass bruise injury resulted.

In considering the total movement from feedlot through slaughter, we found the various periods or handling phases somewhat suggested themselves. That is, certain definite breaks normally occurred and frequently these breaks were marked by a change in the personnel handling the animals.

For example, the first logical phase was loading and, in this instance, this might be done either by the owner-producer or by the trucker. Usually, it was the trucker in the event for-hire transportation was used. A second phase was that period covering the time the animal was actually in transit from the feedlot or ranch to the stockyard or slaughter house. A third phase was the unloading phase.

Then, there was the phase which covered the various movements the animal made after unloading until it reached the final destination. In these tests, this was the packinghouse. This rather long phase, in some instances, could be appropriately termed a yarding phase.

The final phase embraced that period of time beginning with the movement of the animal from packinghouse holding pens to, and including, slaughter. Actually, this phase might be divided into two segments, one concerned with the movement up to the knocking box and, the other, the happenings taking place from the time the animal enters this compartment until it is stuck.

Another way to think of these various phases would be to consider them from the standpoint of responsibility for the animal's welfare. In this instance, from the time loading began until the animals were delivered to their final destination after transit, custody was either in the hands of the owner-producer or a for-hire trucker. A second phase embraced that time when the animal was in the custody of various marketing agencies, and the third, the period after the animal reached the slaughterer.

But, for the purposes of the survey, these categories were somewhat broad. We decided to use the system outlined previously with the various pronounced steps in handling and movement somewhat more compartmentalized.

Accordingly, for this survey, we used the following handling phases: (1) loading—the period of time beginning with the first efforts of the trucker to encourage animals to enter the vehicle and ending with the entrance of the last animal in a test lot into a vehicle; (2) unloading—beginning with the moment the way of exit was opened and ending with the exit of the last animal from the vehicle; (3) yarding—all happenings between the time animals were moved from catch pens at unloading docks until they were delivered to the packing house holding pens; (4) a to-slaughter phase—involving movement from packer holding pens up to the knocking box on the kill line; and (5) the actual slaughter and post-slaughter phase—involving happenings within the knocking box and to the animal after stunning, up to and including sticking.

No provision was made to include a handling phase that would apply to movement while in actual transit. We had hoped that animals could be observed in the vehicle during the movement from feed lot to stockyard. However, in actual operation of the tests, this was found impractical, primarily because the animals were moved in covered vehicles. This situation precluded any observation of them from outside the vehicle.

To compensate for this omission, observers in an automobile followed each of the test loads to note any untoward incidents occurring in the line-haul. However, in all cases, the trip was made smoothly. No situation arose which resulted in animals going down or being subjected to undue jostling or rough handling. No doubt the cattle did sustain some bumps during the movement. Since the animals were rather closely confined, their lack of leverage would reduce the degree of any impact sustained either with the side of the vehicle or with another animal.

While both the tests and the results obtained would be strengthened if we had been able to observe the animals in transit, we do not feel that this lack of observation has seriously weakened the overall operation of the tests or the results.

To provide for the most exact possible identification of potential bruise-causing incidents, we identified each animal in the test lot by number. Three-by-five pieces of a paper resistant to excessive wetting were used for the tags. These tags were numbered by using waterproof ink and the numbers assigned on an arbitrary basis. However, we found it was best to confine the numbers to single or double digits; that is, to make the numbers run from 1 to 99, inclusive.

These paper tags were placed as near the center of the back of the animal as possible, but positioned in the hip area. The same number used on the animal before slaughter was retained for use on the carcass after slaughter. When the hide was removed from the slaughtered animal, a metal tag bearing the same number was placed in the brisket. This number remained on the animal through all the operations incidental to dressing out the carcass, and stayed with the carcass until after a final check was made 24 hours after slaughter in the packinghouse cooler.

We felt some concern as to whether or not the paper tags would remain firmly attached to the animal during the various phases of movement and, particularly, if they would stay on when the animal went through the spray pen immediately before slaughter. The special glue, however, seemed to firmly attach the tag to the hide of the animal. During all the tests, only three tags were lost.

As stated, these tests were conducted under conditions ordinarily prevailing in the movement of livestock from feedlots to and through slaughter. Thus the problem of maintaining a record of potential bruise-causing incidents was much greater than if these tests had been conducted under laboratory conditions. Here it was necessary that the normal operation of movement be maintained and we were unable to ask for special considerations or special facilities. We had to decide on some method which would allow almost instantaneous recording of the potential bruise-causing incidents.

We considered several methods, but finally decided that the most practical means would be to use portable tape recorders.[1] By using these instruments, we could observe and instantaneously record what was seen for transcription later onto regular printed forms.

In practice, we first had to identify a particular handling phase under observation. Then, as the various happenings occurred, we recorded them, stating number assigned to the affected animal and the carcass location where impact occurred. For example if, during the loading phase, animal Number 16 struck his right hip against the rear end door of the truck upon entering, the observer spoke into the microphone, "Number 16, right hip." This was done at each of the various loading phases. Subsequently, the tapes were transcribed and the information transferred to individual cards prepared for each of the test animals (see figure 1, page 5).

We agreed upon a way to estimate impact of the bump. After observing many animals in various movements, through various phases of handling, we decided that where the impact was sufficient to noticeably affect the normal movement of the animal it would be designated as "hard." Likewise, where the impact was little more than a mere grazing of the surface of the carcass against the obstacle, such impact was designated as "light." This left the majority of normal impacts as being undesignated. While this particular classification of impact degrees was certainly not scientific nor exact, it at least recognized that degree of impact was a factor and attempted to evaluate such variations in the only possible manner under less than laboratory controlled conditions.

During most of the various handling phases, three observers were used. They stationed themselves at various vantage points which would allow for maximum observation but, at the same time, were so located as to preclude any overlapping observations. We felt that for the most part the three observers were adequate, although in one or two instances a fourth man would have been helpful. However, too many observers could have caused a duplication in data.

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[1]During certain of the handling phases these portable tape recorders did not function properly. Unfortunately, it was not possible to determine this mechanical defect until after the completion of the handling phase. Of course, it was then too late to make any correction in the data. The author would strongly advise anyone using portable recorders in work of this kind to run a pre-test on the recorder prior to the beginning of each observation period and, in addition to rewind and play back at least some portion of the record whenever a break might occur in the observation period which would give him sufficient time to make such a check on the recording he is making. Even though these precautions may not result in complete elimination of mechanical failure, they should reduce the likelihood of some minor problem with the machine, having the effect of "killing" the entire test. In addition, during loading and unloading and possibly also during yarding if such a defect was discovered and could not be remedied on the spot, a reasonably accurate record could be maintained by resorting to recording observations on tab cards carried by the observer for just such an emergency.

Immediately following slaughter of the animals, observers moved to positions on the packinghouse floor to record the dressed carcasses and the bruise damage, if any. As mentioned, each carcass bore a number identical with that assigned to the animal during the pre-slaughter period. When the carcass reached the trim station, an observer inspected it for bruise injury. If bruises appeared on the carcass, the exact location of the damage was recorded. That is, if a bruise appeared on the left loin of Number 16, we noted this.

When the tissue was trimmed out by a packinghouse inspector, it was placed in a receptacle and weighed. This weight was also recorded in hundredths of a pound. If the carcass showed other damage which might have been due to impact, this was also noted on the form used at trim station.

All information obtained during this post-slaughter check on the packinghouse floor was subsequently transferred to the individual animal's record card. Later on it was correlated with potential bruise data obtained during the pre-slaughter period.

After the dressing operation was completed, the carcasses were hosed and shrouded and placed in the packinghouse cooler. The effect of shrouding, together with the influence of the cooling period, was to finish the carcass. Some bruise damage was not discernible until after this period had elapsed. At some plants the process line moved with such rapidity that occasionally bruise trim was missed by the inspector and was not removed from the carcass until a subsequent inspection in the cooler.

Therefore, on the day following slaughter, observers carefully inspected all test animal carcasses after 24 hours in the cooler. This inspection verified the data obtained at the trim station. It provided an opportunity to make certain that the right carcass location for a particular trim bruise had been noted, and that the trim was assessed against the proper animal. Frequently it was difficult to ascertain which side of the carcass, right or left, had the bruise damage since these carcasses were cut in half before reaching the trim station.

In addition to this verification process, there was a very careful inspection to discover whether or not additional bruise trim had taken place. This happened in a relatively few instances. In these cases, we estimated the weight of the trim removed, based on the judgment of a packer representative and on experience gained during the tests in comparison with bruises actually weighed.

During this cooler inspection, we noted all "fire bruises." These bruises do not need to be trimmed but appear on the fatty surfaces of the carcass as inflamed or reddened spots, popularly referred to as fire spots or fire bruises. They result from impact of sufficient severity to rupture the vascular system but not enough to injure the muscle tissues. For these tests, we decided to record this type bruise since it was evidence of impact.

The dressed weight of each animal and the grade of the carcass was also obtained during the cooler check. We used what might be termed "packer grades." These are based on USDA standard grade terminology; that is, prime, choice, good, standard, utility and commercial. In the packer's case each of the grades was broken down into three categories: top, medium and low. Choice insofar as the packer was concerned would be top choice, medium choice or low choice. These grades were

used rather than the broader USDA terms in order to obtain a more nearly accurate estimate of economic loss later on.

Occasionally, sides of carcasses were damaged to such an extent that packers had to make a discount on the value of the entire side in order to move it in the trade. Such sides were referred to as "devalued" sides, and the loss was referred to as devaluation loss. Such a loss was usually computed on the basis of so many cents or fractions of a cent per pound on the weight of the side. For example, the loss might be 1 cent a pound. If one side of the animal weighed 300 pounds, the devaluation loss would be $3. The range of devaluation loss on a per pound basis was from one-half cent to 3-1/2 cents.

This devaluation loss was arbitrary from the standpoint of the packer and flexible from the standpoint of the current market price of beef. That is to say, devaluation loss was a value judgment of a packer beef department employee. Since these men were well trained in their work, we felt their devaluation figures were trustworthy.

The matter of flexibility came from the fact that devaluation loss could be determined to some extent by the competitive condition in the market for dressed beef at the moment. If the demand for the particular grade was very high, devaluation loss, in order to move the carcass would be less than would be the case if the market was slow. Consequently, a side might take a 2 cent devaluation this week. If the same side appeared in the market next week under an extremely active demand for dressed beef of that type of side, the devaluation might only be 1-3/4 or 1-1/2 cents.

To cover full economic loss sustained by animals in the test lots, we recorded any devalued sides occurring in the tests as well as the packer assessment or devaluation loss. All information obtained during the cooler check was then transcribed to the individual animal's record card. Adding this information gave a complete record of all bruise injury and loss.

Combined with the data obtained during pre-slaughter handling, the card presented a complete picture of all that happened to the animal during the various handling phases and the consequent injury and loss if any. The information on the individual animal's card showed the relationship of potential bruise-causing incidents to actual carcass damage and financial loss.

Conducting tests of the type described above raises the question of whether or not observers or those engaged in the process being observed were biased. In these tests, we made every effort to eliminate observer bias by establishing as inflexible standards of judgment and procedure as the tests would permit. We also made sure the observer thoroughly understood the standards.

Dealing with the bias problem from the standpoint of those handling the animals was not as easy. In the first place, we thought it advisable to fully inform all personnel observed on the nature of our work. This was particularly necessary at stockyards and packinghouses. In these establishments management frequently conducted similar tests before making procedural changes which could affect the employee's livelihood or working conditions. We felt employees should fully understand that an outside agency was conducting the tests, and that the tests were not a company project, and would not be used in any way to affect them personally.

Of course, we requested the personnel to carry on their jobs in the usual manner. However, human nature being what it is, some change in performance techniques or standards was possible because the employee knew and realized someone was watching. This reaction might result in a higher degree of efficiency, which was probably true in most instances. It also might result in an attitude which could lower efficiency.

With this problem in mind, we devised some checks or tests which could be run independently of the survey tests to determine whether or not we were obtaining bias. We ran these checks on all handling phases up to the packinghouse level. At this point, we could not run these checks because the observers were so close to the actual slaughter operations. Any such checks would have ended up with the same bias (if any) that was being obtained on the actual survey tests.

However, we unobtrusively checked loading, unloading and yarding at the various stockyard companies. We believe the results obtained during these checks gave a reliable estimate of actual conditions. We used these results as a standard for measuring bias obtained during these particular handling phases.

We needed these checks at these earlier handling phases, from loading through yarding, for an additional reason. Test lots of animals were all in the category of "directs" and, as such, received only a minimum of handling at the stockyards. In this sense, therefore, they were not typical. The test animals actually received less handling and did not go through all of the same handling steps that a normal lot of cattle, bought and sold in the market, would have to endure. By making the yard checks, as referred to above, we obtained a much more adequate picture of potential bruise injury likely to occur to an average consignment of cattle.

Description of an Actual Test

This description of one of the actual test lots illustrates the techniques used during this survey. This test lot involved 24 steers hauled a distance of about 60 miles from the feedlot and moved direct to the packing plant without going through a stockyard.

The animals were loaded about 7:30 a.m. on Sunday morning and delivered to the holding pens of the packer by 11:00 a.m. They were held in the pens until noon on Monday, and slaughtering operations began at 1:00 p.m. This particular plant was small. The rate of kill was comparatively slow, but all the animals were slaughtered, dressed and in the cooler by 3:00 p.m. Observers conducted the cooler check early Tuesday morning.

A packer-buyer bought the steers in the middle of the week before shipment from the ranch. A for-hire carrier delivered them.

As customary, the observers arrived at the feedlot sufficiently in advance of loading time to thoroughly acquaint themselves with the layout at the lot. No two feedlots were alike, and this was particularly true of the sorting and loading facilities. It was absolutely necessary that observers determine the best possible vantage points for viewing the loading operations.

At this lot, the animals were moved into a small catch pen which funneled down in a V-shape to a loading chute of the ramp type. General construction of facilities was good.

The first step in the tests was to fix the paper tags bearing the identifying numbers on each of the 24 cattle. The tags had been prepared in advance so that the tagging process could proceed expeditiously. The tags had to be applied before beginning the loading. Since this was one of the important handling phases, identification of the animals had to be readily obtainable if a record was to be maintained of potential bruise - causing incidents.

We found early in the preliminary work of the survey that the most practical means of tagging the animals was to confine them in a rather tight holding pen and work from the outside—that is, reach over the fence and place the tag in position. It was next to impossible to tag the animals by walking around through them in a large lot.

With two or three men working from the outside of a small enclosure, it was possible to tag 20 or 30 head of cattle in about 5 to 10 minutes without causing the cattle to become fractious or upset, or without endangering the men who were doing the tagging. Fortunately, the small catch pen at this particular lot was quite adequate to permit this tagging procedure. The 24 steers were tagged in approximately 6 minutes.

The special glue used on the tags was not applied until the tagging operation began. This glue has a rubber base and was extremely viscous. It was best applied by squeezing it from a plastic bottle such as may be found in many homes for use in dispensing mustard or catsup, and spreading it evenly on the tag. The tag was pressed firmly down on the animal, not slapped on the carcass. With the tag so fixed, there was little likelihood of its being lost or coming off the animal during subsequent movement.

We found one of the most important things to remember during the tagging was that the animals be allowed to mill at will, thus bringing themselves sufficiently close to the sides of the confining pen to allow for easy tagging. No effort was made to encourage them to mill, as this could have resulted in injury to the cattle due to increased excitement and emotional upset.

When time for actual loading operations came, the observers took their positions at the pre-selected vantage points. In this particular test, one observer was stationed at the lower end of the loading chute. He observed animals from the time they entered the bottle or V-shaped portion of the catch pen until after they had entered the chute and begun to walk up the ramp into the vehicle.

A second observer was stationed at the top of the ramp, immediately adjacent to the rear door of the semi-trailer. From this position, he observed any untoward incidents happening in the chute and also any bumps the animal sustained as it entered the narrow opening into the truck.

The third observer was stationed at the rear of the catch pen. He centered his attention on any sorting done in selecting animals for loading. He also noted any incidents that occurred back in the catch pen as the animals were encouraged to go into the V and enter the ramp.

The semi-trailer used to transport the animals in this test lot had a partition in the center of the vehicle, dividing the animals into a forward and a rear compartment. This was usually the case where larger semi-trailers were used. When this situation prevailed, the animals were normally divided into two lots, one for the front compartment and one for

the rear compartment, before beginning the loading. Such was the case in this particular test.

Since animals moving into the front compartment of the truck had to pass through a smaller opening, because of the divider or partition in the center of the vehicle, the possibility arose that they might well sustain bruise injury at this time. We could not observe such potential bruise-causing incidents, because the covered trailer and the slatted sides prevented such an observation. But we attempted to ascertain whether or not animals moving in the forward compartments suffered greater bruise damage than those which moved only to the rear end of the vehicle.

In all tests where divided vehicles were used, we recorded the loading order of the animals. Thus we were able to determine which animals had traveled in the front end of the truck and which had traveled in the rear. The observer stationed at the top of the ramp, immediately adjacent to the rear end of the vehicle, obtained this loading order. In this test observers recorded a total of nine potential bruise-causing incidents (bumps). They were equally divided among hip, rib and shoulder bumps. The degree of impact was judged to be "normal," except for one rib bump which was judged "light."

After loading was completed, the trailer began its journey to the packinghouse, followed closely by the observers in a passenger car. No untoward incidents occurred during the journey which could have resulted in throwing the animals off balance and causing them to fall in the truck. The driving was of such nature as to give a smooth and jostle-free ride. All roads traversed, except for approximately 1 mile from the feedlot back to the main highway, were hard surfaced and in excellent condition. The access road from the feedlot to the highway, while being only a dirt road, was also in good shape.

The driver maintained a moderate rate of speed for the first 5 or 10 minutes in order to allow the animals to become accustomed to the motion of the vehicle. He then increased his speed until he traveled approximately 45 to 50 miles an hour on the open highway. He made one stop en route to check the weight of the vehicle at an official State weight inspection station. The stop and start were made smoothly.

Upon arrival at the packinghouse, observers again assumed positions which gave them an opportunity to fully observe the animals as they left the trailer and during movement from the truck to the packinghouse holding pens. One observer was stationed directly adjacent to the rear opening of the vehicle, another approximately 15 or 20 feet beyond at a point where the alleyway turned, and the third at the entrance to the holding pen.

In this test, animals stepped directly from the trailer onto the level surface of the receiving alley. It was not necessary for them to descend a ramp or steps. When the door to the truck was opened, the animals began to come out in a very few seconds and unloaded without any encouragement or persuasion on the part of the driver. There was little or no crowding on the part of the steers as they left the truck. During the entire unloading process, only two bumps were observed. Both of these were light bumps on the hip area.

We observed a total of four bumps during the yarding phase of this particular segment of the test; that is, from the time the animals were actually out

of the truck until they were in the holding pens. One bump was on the rib, two on the shoulder, and one light bump on the rump.

The receiving facilities at the packinghouse were as nearly ideal as it would be possible to expect. Further, the handling accorded the test animals was extremely good. Since it was a Sunday morning, there was no necessity for hurry. The animals more or less unloaded and yarded themselves.

This test lot of animals was scheduled to go "on the kill" at 1:00 p.m., Monday. They remained in the holding pen to which they were yarded upon receipt at the packinghouse until about 30 minutes before this time.

Then the gate to the holding pen was opened and the animals moved out into the wide approach alley which led to the slaughter area. Again, since these animals were the first to be killed on this particular day, there was no hurry. They probably received somewhat more favorable treatment than if the test lot had been sandwiched into the middle of a kill day.

In this test, we divided out observation of potential bruise-causing incidents into two phases. One covered the time from the animal's departure from the holding pen up to the entrance to the last segment of the alley leading to the knocking box. The other phase covered movement from that point through the knocking box and, from the knocking box after stunning, to the floor of the sticking section of the slaughter area. Three observers were used, one stationed back along the alley to watch all action embraced in the first phase, another at the knocking box, and a third down on the floor.

Because of the arrangement of the facilities at this plant, we believe that observations obtained during this test were extremely accurate. Perhaps a brief description of the facilities will support this statement.

The total distance embraced in phase 1, described above, was approximately 150 feet. This covered from the exit of the exterior holding pen to the entrance to the packinghouse kill area. While there were no turns to be traversed, the total length was broken into four sections by movable gates. The first section covered a distance of approximately 75 feet. The alley at this point was about 10 feet wide.

The second section was about 25 feet long, and the third 15 feet long, both of these also about 10 feet in width.

The third section covered a distance of only 8 or 10 feet. The sides came in in a funnel-like arrangement, narrowing to a doorway which admitted only one animal to the narrow alley approaching the knocking box.

An overhead catwalk extended over the last three sections of this distance. From the catwalk the observer had an unobstructed view of the animals moving along this area. By going to the far end of the catwalk, the observer was able to maintain a constant view of the animals as they left the holding pen and moved along the first or 75 foot section. The distance from the end of the catwalk to the exit of the holding pen was short enough to allow positive identification of any animals sustaining potential bruise-causing incidents.

The second handling phase described in the paragraph above was likewise easy for an observer to monitor. The facilities here included a narrow alleyway

approximately 10 to 12 feet in length, just wide enough to accommodate animals single file. This led directly to the knocking box, built to accommodate a single animal. A walkway, adjacent to the alley and the knocking box, was located in such manner that the observer could easily see what was going on when the animal was moving through the alleyway and while he was in the box.

After the animal was stunned, the side of the knocking box opened and the animal slid onto the kill floor where it was shackled, raised and moved on the chain to the sticking area. An observer stationed on the floor at this point could easily see the animal slide from the box and watch anything happening during the shackling process. Principally this observer recorded the degree of impact which the animal sustained in sliding from the box and noted which side of the carcass was affected.

The operational procedure here was to move the animals from the holding pen along the first or 75 foot segment of the alley and into the second or 25 foot section, where they were halted. At this point, the sprayers were turned on and the animals drenched in order to cool them down. After a few minutes of drenching, a portion of the animals were then released into the third section (the 15 foot section). From there the driver herded them through the remaining sections of the facilities to the knocking box.

The smaller 10 foot section of the alleyway (the funnel-shaped section) was normally cut off and made a separate section only when three or four animals were left. As long as sufficient animals were in the combined area (the 10 and 15 foot sections opened together) excessive milling was not a problem. The animals turned off into the single file necessary to go into the small alleyway leading directly to the knocking box. However, when practically all animals had been slaughtered and only two or three remained, closing them off into the funnel-shaped section avoided excessive milling. The animals could be more easily encouraged to enter through the small opening door into the single file section of the alley.

As previously stated, the knocking box at this plant was built to accommodate one animal at a time so the rate of kill here was on the basis of a single animal. This, of course, made observation of animals within the knocking box much more accurate, as well as easier.

Observations made during these last two phases of this test netted the following result. In the first phase (covering exit from the holding pens to entrance into the single file alleyway) we recorded 19 hip bumps—2 "hard," 8 rib bumps, 7 shoulder—1 "hard," 10 bumps on unspecified carcass locations (parts of the carcass other than those embraced by the aforementioned categories), making a total of 44 bumps in phase 1. In phase 2 (covering movement through the single file alley and while in the knocking box for stunning) we noted 8 hip bumps, 1 rib, 7 shoulder and 7 on other carcass locations or a total of 23 bumps.

A total of 82 potential bruise-causing incidents (bumps) occurred during this test. When this information was transcribed to the individual animal's record card, we found that three animals had received no observed potential bruise-causing incidents.

As the carcasses of the animals passed the trim station, they were observed while all bruise tissue trimmed from the carcass was weighed. There were 13 such bruises, having a total weight of 3.46 pounds. In this test, more than half of the trim bruises were on the shoulder.

The following day, when the carcasses were checked in the cooler, no additional trim was found but 23 fire bruises were noted. These were about equally divided between hip, rib and shoulder.

With the record of potential bruise-causing incidents and the record of actual bruise injury available, the next step was to calculate the financial loss sustained and to attempt to relate the actual bruises to the potential damage record.

The method for determining economic bruise loss was a relatively simple one. We decided the most practical means would be to use prices of primal cuts, as listed in The Provisioner for the current week on the Chicago market. By multiplying this price by the weight of the trimmed tissue from that particular carcass location, we obtained a trim value. For example, if the price of choice ribs was quoted at 50 cents a pound and there was one-half pound trimmed from the ribs, then the loss would be 25 cents.

This was done for loins, ribs, shoulders and the like, but there were occasions where trimmed tissue occurred from areas not included in these prices. For instance, bruised tissue might be removed from the back of the animal. To estimate loss of this tissue we used the carcass price. If choice steers of this particular weight were quoted at 40 cents a pound for the side and half pound of trim was indicated in the "other" category, we set the bruise loss at 20 cents.

On the basis of prices for the week during which this test was conducted, the 3.46 pounds of bruised tissue trimmed from the carcasses of the 24 steers was valued at $1.49.

This test showed a strong relationship between potential bruise-causing incidents, and bruises appearing on the carcass after slaughter. We established this relationship from the record card of each animal. After ascertaining the carcass location of the bruised tissue, we checked the record of potential bruise-causing incidents for the same carcass location. By using this procedure, we could determine whether or not a potential injury affected the animal at the same carcass point during the time it was under observation and, if so, during what handling phase the event occurred.

For example, in this test, we found that animal Number 39 had a bruise on the left hip. This bruise resulted in a quarter of a pound trim, valued at 17 cents. When we consulted the record of events during the various handling phases, we found that Number 39 had suffered a bump on the left hip while being unloaded from the vehicle after traveling from the ranch to the packing plant. This was the only observed incident affecting that particular carcass location from the time the animal was sorted for loading until he had been slaughtered. On that basis, we could say that in all likelihood the bruise injury on the left hip occurred during unloading.

Using this method, we identified 11 of the 13 bruises which resulted in trims. These accounted for the one hip bruise, the three bruises observed at other parts of the carcass, one of the rib bruises, and six of the shoulder bruises. One rib bruise and one shoulder bruise could not be related to any observed bump.

The same procedure was used in an attempt to identify fire bruises. We related 14 of 23 such bruises to various incidents recorded during the handling phases.

The identified bruises, which resulted in trimming of bruise tissue from the carcasses, represented 85 percent of

all trim bruises and accounted for 84 percent of the total trim weight and 85 percent of the total financial loss. Sixty-one percent of the fire bruises were identified. Sides of carcasses were not damaged enough to require devaluation. Hence, we did not assess any devaluation loss against this test lot.

As to where the identified bruises happened, one trim bruise occurred during unloading; one during initial yarding, that is, after the animals were unloaded from the truck until they reached the packer holding pens; and the remaining nine occurred during the movement from holding pens through and including slaughter. All fire bruises, except one which was related to an incident during the loading phase, occurred during the final movement of the animals to slaughter.

This test description illustrates the various methods and techniques used and poses some of the problems in conducting the tests during this survey. No two tests were alike. Facilities, handlers, and animals themselves all varied. However, this test may be considered typical, except that the incidence of bruise loss was extremely low.

Actually, the financial loss in this test figured out to about 6.2 cents a head, far below the estimated average bruise loss, and the lowest of all tests. But this was not too surprising for the facilities at this particular packing plant were excellent. In addition, loading facilities back at the ranch, the vehicle which moved the animals to the packinghouse, and the care with which that vehicle was driven were all of near model character.

The relatively strong relationship between bruise-causing incidents and bruise results established in this test was probably due to the fact that all of the various handling phases were easily observed and that the record maintained of potential bruise-causing incidents (bumps) was probably as accurate as possible for human eyes to detect and a human voice to record. Certainly, the conditions surrounding this test contributed much to its being one of the most successful ones conducted during the survey.

One observation should be made at this point which applied to this particular test and to all of the other tests in the survey. We have indicated that during the various handling phases an effort was made to record all bumps the various animals sustained. When a group of animals is moving along an alleyway or going through various movements ordinarily occurring in marketing livestock, an observer finds it difficult to see everything that happens.

We did a great deal of experimental observing before the beginning of these tests. We first established how much could be observed and recorded. In most instances we found it would be impossible to watch for bumps which might occur by the animal contacting a facility and, at the same time, to maintain an equally good record of bumps occasioned by the collision of two animals—body to body.

We decided to devote our principal attention to making a record of bumps by animal contact with facility rather than with another animal. The reason for the decision was twofold. First, the degree of impact with a facility was likely to be greater than with another body, resulting in heavier or more extensive bruise damage. This was borne to some extent in the previously referred to Ohio bruise work. Second, body to body injury was caused in many cases by the facility or by the human factor as reflected in the way the moving animals were handled.

Since the basic purpose of the survey and the tests was to isolate these conditions and practices which brought on bruise damage, with the hope that correctional measures might be taken, it seemed logical to concentrate on those areas for which people were responsible.

However, where we were able to include potential injuries from the impact of one animal with another, we made them a part of the test record. In addition, during the final handling phase of all of the tests, that is, that portion involving the last movement into the knocking box and in the knocking box, we always observed and recorded animal to animal contact. Here the distance involved was extremely limited and it was easy to get that type of information.

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